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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK 153, 168
Transportation of 30-Ton Girders at Binghamton, N. Y. (illustrated) 154
Improvement of the Terminal Facilities at the Port of New York 154
The Economic Depth for Canals of Large Traffic.. 155
Designs for the Massachusetts Ave. Viaduct, Washington, D. C. (with full-page plate) 156
A Rock-Fill Dam with a Steel Heart Wall at Otay, Cal. (with full-page plate) 157
Operation and Maintenance of the Block System on Single Track; C., N. O. & T. P. Ry. (illustrated). 158
An Improvement in Wire Fencing 159
The Establishment and Conservation of the Purity of Public Water Supplies 163
Development of the Iron Ore Industry in the Lake Region 163
The Scott Gravity Boiler Feed Apparatus (illustrated) 164
Sandless Pig Iron—Its Advantages to the Producer and Consumer 164
The Crow's Nest Pass Extension of the Canadian Pacific Ry 165
Derailing Switch Accident at Franklin Park, Ill. (illustrated) 166
Classification of Lakes According to Temperature.. 166
A Highway Bridge with Concrete and Brick Floor (illustrated) 166
Uses of Small Sizes of Anthracite Coal for Steam Making 167
Book Reviews 168
EDITORIAL NOTES 160
The Newburyport, Mass., Water-Works Franchise Case—Proposed Legislation in New York to Protect Corporation Franchises—Injustice of Making Private Consumers Pay for Water Used for Public Purposes—Final Settlement of the New Orleans Garbage Disposal Controversy—The Retirement of E. O. Matthews, U. S. N.
EDITORIAL 161
Terminal Facilities of the Port of New York.
LETTERS TO THE EDITOR 162
Increase of Bridge Strains with Velocity of Trains—The Port Arthur Terminus and Ship Canal of the Kansas City, Pittsburg & Gulf R. R.—An Inquiry Concerning Mechanical Root Extractors—Concerning the Niagara River Bridge—Building a Coffer-Dam Around the "Maine."

THE WATER SUPPLY CRISIS AT PHILADELPHIA, reviewed editorially in our last issue, assumed a more favorable aspect on Wednesday. When the measure came up for final passage in the select council one member changed his vote, urging that friends and constituents had advised him to do so in the interests of the city. The bill passed, but it lacked just this one-vote of having the three-fifths majority necessary to pass it over the promised veto of Mayor Warwick. A quorum was lacking at the time the bill was to come up in special session of the common council, so it went over until Thursday. On that day the bill narrowly escaped indefinite postponement, and was amended by the common council so materially that it is believed the Schuylkill Valley Water Co. would not accept it in that form. One of the amendments called for a duplicate supply conduit, which would be many miles in length and cost heavily; another called for a 100,000,000-gallon reservoir at West Philadelphia; still another provided that the filtered water must be delivered into the present reservoirs, instead of at pumping stations. The events of these two days resulted in a halt, but as a special meeting was called for Tuesday of the present week the assumption is that one side or the other has taken courage and believes that victory is assured. On whose banners victory will be emblazoned we shall not attempt to predict.

NEW WATER MAINS are to be laid in Chicago this season to the extent of 37½ miles, including ¼ mile of 48-in. pipe, 19 miles of 36-in., 3½ miles of 30-in., 5½ miles of 24-in., 7½ miles of 16-in. and 1¾ miles of 12-in. The new mains are to give greater pressure in the upper part of the South Side and the southeastern part of the West Side.

SLOW SAND FILTRATION AT READING, PA., has been recommended by the water board of that city, of which Mr. Emil Nuebling is Superintendent, and Mr. Allen Hazen, Assoc. M. Am. Soc. C. E., is consulting engineer. The estimated cost of filtering the whole supply is about $285,000, and the total annual charges for operating expenses and interest are estimated at $21,390. It appears that four different plants, for supplies from as many sources, would be required. Two of these would be built first, giving a total daily capacity of 12,500,000 gallons and costing $236,500 for construction and $16,950 for operating expenses and interest. The authorization of a $300,000 loan is recommended, but councils have taken no action on the matter yet.

COMPENSATION FOR WATER RIGHTS affected by the new water supply of Syracuse, N. Y., have just been awarded to various parties to the total amount of $259,020. The rights involved pertained to property along the outlet to Skaneateles Lake. We are indebted to Mr. Wm. R. Hill, M. Am. Soc. C. E., Chief Engineer and Superintendent of the Syracuse Water-Works, for the above information.

A ROAD IMPROVEMENT BILL is now before the New York legislature. The bill is similar to the one already in force in New Jersey and some other states. It provides for road construction at the joint expense of state, county and town, the state paying 50%, the county 35% and the town 15%. This general plan has worked well in a number of states. It stimulates the demand for improved roads, both on account of the state aid given and because each stretch of such road is an object lesson of their value and of how they should be built.

A BLOCKADE OF TROLLEY CARS occurred on the Brooklyn Bridge shortly after 9 a. m. March 7. At present cars from 14 lines run across the bridge, at the rate of about 3½ cars per minute between 7 and 8 a. m., 3 4-5 cars per minute between 8 and 9 a. m., and 3 1-10 cars per minute between 9 and 10 a. m. These cars are packed, and must be unloaded, loaded and switched at the rate of about one per minute. Allowing 40 passengers to a car, it is estimated that fully 12,000 persons were inconvenienced by the blockade.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the West Shore R. R., about a half mile west of Fayetteville, N. Y., on March 2. A train composed of 36 freight cars loaded with ice ran away on a down grade, owing to slippery rails. The engine finally broke loose, jumped the track and caused the wreck, which killed both engineer and fireman, besides injuring two brakemen.

ELECTRIC TRACTION is to be introduced on the Evanston branch of the Chicago, Milwaukee & St. Paul Ry., if the city passes an ordinance now before the council. The trolley system will be used, and it is expected that with the high speed attainable when the track elevation work is completed the line will be able to compete successfully with the surface electric lines, which now carry the greater part of the traffic. The branch has never been a paying concern while operated by steam. The electric line, however, cannot enter the Union Station, but must stop at Kinzie St. and the Chicago River, and it is rumored that a connection may be made with the Northwestern Elevated R. R. at Wilson Ave. Freight trains operated by steam will be run during the night.

THE CONTRACT FOR THE MOTOR EQUIPMENT of the Brooklyn Elevated has been awarded to the Walker Co., of Cleveland, O. The contract calls for 50 motors of the Short type, with a future increase of 100. These will be 80-HP., 4-pole steel machines, running at 450 revolutions per minute. In their construction only fireproof material will be used, all insulation being mica or asbestos. These motors will be mounted on McGuire trucks, each car having two motors. The Sprague multiple unit system of control will be used.

PHOTOGRAPHS OF 150,000-VOLT DISCHARGES, obtained by Mr. C. P. Steinmetz during a series of experiments performed to investigate disruptive discharges in circuits with very high voltage, and published as a supplement to the "Electrical World" for March 5, 1898, form an interesting addition to what little is known on this subject. To produce this high potential a single-phase 125-cycle alternating generator and 12 transformers giving a final transformation ratio of 1 to 144 were used. Two brass spheres 2½ ins. in diameter were used as discharge terminals; these were placed 14 ins. apart and in some cases 15 ins. The maximum output at these terminals was about 35.5 K-W. To obtain the pictures the camera was placed and focused and the time of exposure was controlled by a switch in the generator circuit. In conclusion, Mr. Steinmetz states: "The discharge of a high potential circuit is always oscillating; even if sufficient power is behind the circuit to maintain an arc. An arc impelled by extremely high voltage and with considerable power behind it is in continuous and very rapid eddying motion.

ELECTRICAL EXHIBITS at the Trans-Mississippi Exposition will include a special exhibit of the apparatus and inventions of Thomas A. Edison; various vacuum tube lighting systems; working models of the syncronograph and syncronoscope, both inventions of Lieut. G. O. Squires and Prof. A. C. Crehore; systems of military telegraphy and telephony; Tesla's oscillator and other devices; telegraphing at sea without wires; forms of third rail electric railways; alternating current railway motors; storage battery traction; electricity applied to agriculture; kite flying, with a view of determining the electrical condition of the atmosphere; electric vehicles, and many other modern applications of electricity.

PARABOLIC REFLECTORS MADE BY AN ELECTROlytic process are being manufactured in England with considerable success. As described in the London "Electrician," of Feb. 25, 1898, the process employs a glass mold, the convex side of which is polished and ground to form a true parabolic surface. On this surface is deposited a coating of metallic silver to form a surface upon which is in turn deposited copper to a thickness sufficient to give proper strength. The reflector is next removed from the glass by placing both in water, which is gradually heated until the unequal expansion of the materials separates them. The basin-shaped reflector is next filled with a solution of palladium ammonium chloride and a coating of palladium is electrically deposited upon the inner surface. The reflector is then polished and suitably mounted. Various tests show that neither the intense heat of the arc nor salt water affect the surface and that bullets puncture the metal with little effect, whereas glass reflectors would be shattered.

DYNAMITE WAS USED TO SEPARATE parts of the cable machinery in the power house of the Capital Traction Co., Washington, D. C., which was destroyed by fire some months ago (Eng. News, Oct. 7, 1897). Attempts to separate the hubs of some of the large wheels from their shafts proved fruitless, and as a last resort they were blown off. Notwithstanding the fact that precautions were taken to prevent accident, portions of the wheel were blown several blocks. Fortunately no one was injured.

ALL OVERHEAD WIRES IN LOS ANGELES MUST be placed underground, according to reports. The ordinance provides for a system of conduits to be constructed and used in common by the various electrical companies.

LIGHTING THE PYRAMIDS OF EGYPT with electricity and the installation of a 25,000-HP. power plant, to cost some $400,000, is a plan now under consideration by the British government, and the Westinghouse Electric & Mfg. Co., of Pittsburg, Pa., are reported as likely to receive the contract. As outlined the plan includes the generation of electric power at the Assouan Falls on the Nile River and its transmission a distance of 100 miles through the cotton-growing districts, where, it is believed, the cheap power will permit the building of cotton factories. It is planned to use the power to illuminate the interior corridors of the pyramids and also operate pumping machinery for irrigating large areas of desert along the Nile.

THE NEBRASKA MAXIMUM RATES CASE has been decided in favor of the railway companies by the United States Supreme Court, thus upholding the decision of the U. S. Circuit Court, rendered in December, 1894. The case, was, briefly, as follows: In 1893 the state of Nebraska passed a law establishing maximum freight rates to be charged by the railways of that state. These rates, according to the investigations afterwards made by the courts, made a reduction of about 29½% in the local freight rates then in force, and the railways appealed to the courts to relieve them from obeying the law. As stated, the appeal of the railways was upheld by the Circuit Court. The state therefore carried the case to the U. S. Supreme Court and the decision just rendered is the decision on this final appeal. Briefly, the present decision declares that the law is contrary to the fourteenth amendment to the Constitution, since the figures presented showed that, with a reduction of the rates amounting to 29½%, "each of the roads involved would have conducted its business at a loss, with only one or two exceptions, and those for only a short while."

THE RAILWAYS OF SWITZERLAND are to be purchased by the State at a cost of about $200,000,000; the people, by popular vote, having approved of this action. The five principal lines involved aggregate about 2,340 miles of railway now open to traffic; and at the above figures the price to be paid averages nearly $100,000 per mile, including all other railway property and rights.

A TUNNEL UNDER THE STRAIT OF GIBRALTAR is proposed by M. Berlier, who lately drove the tunnel under the Seine for the sewage disposal of Paris. Aside from its assumed commercial use, M. Berlier tells the French people that it would be extremely valuable in connecting France with Algeria, in case of any trouble with England, which now controls the surface of the Strait with its fortifications and powerful navy. Be this as it may, the engineering features of the plan may be noted as follows: The tunnel would begin on Spanish soil at the Bay of Vaqueros, on the line to Cadiz; it would then cross straight to Tangiers with a submarine tunnel 19.84 miles long, or with its tunneled land approaches, 25.4 miles long; a 25-mile railway would connect it with with Ceuta on the Algerian side. At the narrowest part the Strait is only 8.7 miles wide; but the depth of water there is 1,968 ft., and the consequent grades would make a tunnel impracticable. At the site of the proposed crossing the depth of water is 1,312 ft.; and with the length proposed he finds permissible grades and thinks it would not be more difficult to construct than the Alpine tunnels; in fact, he estimates that it would cost about $200 per lin. ft., or $24,600,000 in all. To connect it with the Algerian railway system, 279 miles of railway would have to be built, at a further cost of about $18,000,000. It does not appear whether M. Berlier has any knowledge of the character of the strata which would be pierced by the proposed tunnel; and we need hardly say that unless the tunnel could be kept in absolutely impervious rock all the way across, the scheme would be as impracticable as Jules Verne's famous "Journey to the Moon."

TRANSPORTATION OF 30-TON GIRDERS AT BINGHAMTON, N. Y.

The Ferry St. bridge, in the city of Binghamton, N. Y., consists of four girder spans, of 88 ft. 4 ins. each in total length. Ferry St. is only 54 ft. wide, and in turning the corner there was but one foot to spare, owing to shade trees and telegraph poles. These conditions necessitated a special method of transport for these girders, and the plan adopted by the Owego Bridge Co., of Owego, N. Y., the builders of the bridge, is here described. To the courtesy of Mr. Ellery Colby, President of that company, we are indebted for the photograph reproduced herewith.

MOVING A 30-TON GIRDER THROUGH A STREET AT BINGHAMTON, N. Y.
The Owego Bridge Co., Owego, N. Y.

As shown in this view, two sets of cross timbers were bolted near the ends of the girders, and under the projecting ends of these timbers were located four steel castor wheels and frames. These wheels were 26 ins. in diameter, and 10 ins. tread, and into the turntable attached to each an ordinary wagon-tongue was inserted. Each pair of tongues was connected by a small cross-piece, so that the castors would move together and keep in line. A man at each tongue steered the castors easily. The facility with which each pair of castors could be turned enabled the street corner to be rounded without difficulty or delay. At the time the girders were moved the streets were covered with snow and ice to a depth, in some places, of 6 or 8 ins., and a team and tackle was used to pull the girder along. Had the street's surface been clear of this snow and ice, 6 or 8 horses would have moved the load without tackle. As it was, the distance, of about one-half mile, from the railway to the bridge site, was made in 1 hour, 35 minutes.

IMPROVEMENT OF THE TERMINAL FACILITIES AT THE PORT OF NEW YORK.

The future commercial supremacy of the port of New York depends very largely upon the degree to which its facilities are developed for the economical handling of freight between the ocean steamer and the warehouse or the railway. The impairment of this supremacy is already recognized in the urgent demands by the merchants and business men of New York for deeper and wider channels to the sea, and especially for a greater number of large docks, equipped for the most economical handling of traffic. Work upon the new docks planned two years ago is already in progress, and the board of consulting engineers to the Dock Department has presented several reports upon the methods proposed for the transfer of goods between the ships and the railways. In this connection the New York "Journal of Commerce" has been doing an excellent work in gathering and publishing the opinions of engineers and business men upon the changes proposed by this board.

In 1897 New York's proportion of the whole foreign imports of the country was 63.3%, as compared with 69% in 1877. In the same period New York's proportion of the total exports of the country has fallen from 43.6% in 1877, to 41.5% in 1897. Of the total foreign commerce of the country, export and import, which was $1,207,000,000 in 1877, New York's share was $648,300,000, or 53.7%. Of the total of 1897, $2,033,600,000 in value, New York's share was $1,036,200,000, or 51%. While this decline of only 2.7% in 20 years may seem trifling when the general development of the country is considered, other facts make it alarming to the business men of New York. For example, while there was a gain of 43% in the total exports of cotton in 1897, New York's proportion of this export was practically stationary; with a gain of 40% in the total export of breadstuffs, in 1897 over 1896, there was an actual loss in the amount shipped from New York; and the same is true of a gain of 22% total shipment of provisions from the United States. These facts are in themselves of sufficient importance to warrant even greater efforts towards regaining lost prestige than are now being made.

In April, 1897, a report was made to the Department of Docks, embodying a plan for river-front improvement, by a board of consulting engineers made up of Gen. W. P. Craighill, Mr. George S. Morison and Prof. Wm. H. Burr, the first two Past Presidents and the latter a Member of the American Society of Civil Engineers. The "Journal of Commerce" submitted this plan to Mr. C. W. Buchholz, M. Am. Soc. C. E., Chief Engineer of the Erie Railroad Co., for his criticism. In connection with the duties of his office, Mr. Buchholz has closely studied the problem of the transfer of merchandise in the port of New York, and his views may be briefly expressed as follows:

The experts' plan contemplated the construction of a four-track freight railway, along the North River, from the Battery to Christopher St. It was proposed to keep the two middle tracks open as main lines, to be operated by switching engines, and to use the two outside tracks for the storage of cars, accessible by trucks and teams for loading and unloading. From the outside track, on the water side, spur tracks would run to the piers when desirable; and similar spurs could be led from the inside track to warehouses, etc. The board of engineers, to reduce the number of float-landings and save water-front, proposed to terminate the four tracks, about Castle Garden, in an apron adapted to a four-track transfer-boat capable of carrying 40 cars at once. It was claimed that this system of surface tracks would serve the interest of all parties affected, and greatly improve and enlarge the facilities for handling freight. The use of elevated tracks on this line was carefully investigated by these engineers; but the inherent difficulties and inconveniences of such a system made it impracticable.

Mr. Buchholz takes exception to this solution of the problem. He first calls attention to the existing facilities, as represented by floats bearing railway cars, barges, and floating elevators. Based upon daily returns of the freight moved across the North River, in both directions, by eight railways having terminals in New York, he gives the following estimate of the daily average movement:

Estimated Daily Movement of Freight To and From Points on the North River.

Railroads Participating.	By floats. Eastward. Loaded. Cars.	Empty. Cars.	By floats. Westward. L'ded. Cars.	Empty. Cars.
Erie	90	40	75	55
N. Y. C. & H. R.	60	30	50	40
West Shore	110	20	105	35
Pennsylvania	125	35	90	70
Baltimore & Ohio	50	30	60	20
Lehigh Valley	70	30	60	40
C. R. R. of N. Jersey	145	40	140	45
Del., Lack. & West.	40	15	35	20
Total	690	240	615	315

Railroads Participating.	Barges. East. Tons.	West. Tons.	Total employed. Floats.	Car Capacity.	Barges.
Erie	625	350	23	211	60
N. Y. C. & H. R.	590	100	15	140	66
West Shore	310	70	10	103	*
Pennsylvania	600	325	32	272	65
Baltimore & Ohio	150	225	16	172	54
Lehigh Valley	375	300	10	112	30
C. R. R. of N. J.	340	210	18	225	23
Del., Lack. & W.	100	150	15	140	30
Total	3,090	1,730	139	1,373	328

*Included in N. Y. C. & H. R.

In this estimate no account is taken of the floating elevators, as their transportation service is difficult to average, and their traffic has no bearing on the construction of the proposed freight railway on West St. As a general average, about three times as much freight is moved across the river on loaded cars on floats as is moved by barges and lighters. As one purpose of the railway proposed is to eliminate the lighter from the business of freight transfer, we must assume that the number of cars daily loaded and unloaded in New York would considerably increase. But Mr. Buchholz finds difficulty in fitting even the present volume of car service into the facilities which the proposed railway on West St. would have. From the table above, it will be seen that, for the Erie Railway alone, there is a total daily movement of 260 cars, which, if placed in line, would occupy 8,700 ft., or 1.64 miles of tracks. Under present arrangements at Chambers St., with a frontage of 400 ft., there is room for 12 cars on either of the side tracks, at one time. Goods for New York are easily unloaded on trucks, and Westbound merchandise is sorted and put on the appropriate car on the float, and is thus ready for immediate dispatch when the car is delivered in Jersey City. Mr. Buchholz believes that this systematic handling of goods would be impossible with a line of cars standing on a marginal track on West St., and separated from the main thoroughfare by a fence. With the two center tracks kept open for operation, the cars which are being unloaded would be separated from those which are to be loaded again. The option given, he says, is the loading of freight as it comes, irrespective of character or destination, leaving it to be re-assorted in Jersey City; or, the privilege of stringing out the cars of the Erie Co., from Chambers St. halfway to the Battery. The first method would be open to objection from the shippers, and the second would meet the opposition of other railway companies, and of the city itself.

As Mr. Buchholz intimates, few realize the part now played by the North River as a freight or distribution yard in the handling of cars on floats. Eight different railways now move daily 930 full or empty cars out of New York and across the North River. With the present average car capacity this movement requires 93 floats. The four-track transfer boat proposed would hold 40 cars, and each railway company would be supposed to own or operate one or more boats of this class. But where are the 40-car trains to be made up? As they would obviously be composed of both full and empty cars, they could not be made up on the side tracks of the freight railway, for these are occupied by cars in the process of loading and unloading. If made up on the middle tracks, what becomes of the freedom for circulation claimed by the board? Then each of the eight companies must have its own 40-car train made up in its own time, and have its own boat waiting at Castle Garden to receive it. There would be on an average 23 such trains going westward every day, or three for each railway; each train with its engine would

occupy about 1,400 ft. of track; and eight of them in line at once would occupy about 2⅛ miles. Mr. Buchholz says that the physical impossibility of operating such a system as that proposed is obvious.

The Board of Consulting Engineers also stated that "goods brought to the piers, whether they come by railways, or from within the city, are now subjected to inconvenient and expensive methods of handling"; and as better methods are found in other and rival ports their existence is demanded in New York; the railway was, therefore, proposed as a means of facilitating the interchange of traffic between land and water lines of transportation. Mr. Buchholz, in commenting on this statement, denies the claimed great advantages of railways on or near the piers. He gives the figures for the present practice of the North German Lloyd Steamship Co., which docks in Hoboken, where railway facilities could be easily secured, if wanted. But this company will not allow tracks and cars on its piers, simply because these would seriously interfere with the use of these piers for purposes of temporary storage, and for sorting freight. He believes this reason would apply quite as well to the New York as to the Jersey side of the river. You cannot load grain into ships from a railway car, and an elevator must be employed. As to the flour business, most of it is lake and railway freight, and in the grain season it is rushed to the seaboard faster than ships can take it. Ocean shipments go on all the year around, and to establish a proper relation between the income and outgo, much of this railway and lake freight has to be stored at this port, or at Buffalo, and taken out as called for. The railways do this, by unloading the cars into their warehouses and by delivering the freight into barges which can take it to the ship, wherever that ship may be. Even with an occasional steamer carrying nothing but flour, a cargo of 40,000 barrels would equal 4,000 tons, or a load for 160 cars; and such a train could not be assembled without considerable previous preparation.

As to cotton exported, that coming by southern steamers is most expeditiously and economically delivered to the ship by lighters. The cotton which comes by rail can also be delivered more cheaply by lighters, than by running the cars on floats and unloading them on the New York side. Of all the tobacco taken by the North German Lloyd steamers, 90% is lightered, and only 10% brought by carts; and the proportion would not have been materially different if the work had been done on the New York side. In analyzing the character and destination of goods landed on the New York side, Mr. Buchholz comes to the same conclusion—that there would be little use for the West St. railway tracks.

Mr. Walter Katte, Chief Engineer of the New York Central & Hudson River R. R., on being interviewed by the "Journal of Commerce," agreed fully with the position taken by Mr. Buchholz. On the tracks of this road, now coming down West St. as far as Canal St., the present daytime movement of cars is exceedingly slow. The board of engineers proposes to remedy this trouble by a series of bridges over the four-track railway, taking the passenger traffic to the river front. But, as Mr. Katte points out, this arrangement would not relieve the street from the steady line of trucks and carriages crossing to the ferries, or those passing to and from the steamship piers. Mr. Katte doubts if the work failing to the lot of the railways could be done by any method much cheaper than at present.

Mr. George S. Morison, a member of the Board of Consulting Engineers, answers these strictures upon the report of himself and his colleagues, practically as follows: The board of engineers did not propose the four-track railway as a substitute for the present methods of transferring and interchanging freight by floats, but as an addition to these existing facilities. Such a railway would in no way interfere with the passage of lighters and floats on the river, and the lighters could still be brought alongside the steamers whenever convenience and economy suggested such a course. But where commerce is now limited to the use of the lighters, it would, with the railway, have a choice, wherever railways would better suit its purpose. Mr. Morison refers to the harbor of Brooklyn, where the wharves and warehouses are served by such a railway, as evidence that there is a class of traffic demanding railway service.

As to congestion and inconvenience in operating such a four-track road on West St., Mr. Morison says that the plans of the board contemplate taking their present street railway out of the street and placing it on an elevated structure, and thus a clear, unobstructed street, wider than Broadway between curblines, would be left inside of the fence line spoken of by Mr. Buchholz. The large bridge for transfer boats, landing at the lower end of the four-track road, was supposed to simply supplement other bridges for float connections, located at such points along the line as convenience might suggest. The railway would serve as a connection between these bridges, with such ground as might be secured for railway yards on the east side of West St. In this respect it would be simply an amplification of the Erie freight station at the foot of 23d St., and would make such stations available to all the companies.

Mr. Morison says that one important aspect of the situation is not referred to by his railway critics, and that is that the railway interest is, in many respects, adverse to the interests of the port. On the North River front, the only part of the New York water front available for modern steamships, two years ago, the transatlantic steamers occupied 13%, of the 2½ miles between the Battery and Gansevoort St., and the railways used 29% of this same front. This was done because there were no facilities for bringing the cars ashore, and the slips which should have been filled with ocean-going vessels were crowded with floats holding cars which were being loaded or unloaded. This business had little or nothing to do with foreign commerce. The city has lately acquired land, and contemplates acquiring more along this water front for giving additional dock room to ocean-going vessels. If the railways were compelled to purchase land for their own use, and to build suitable stations upon it, more of this front would be available for ocean commerce. In conclusion, Mr. Morison suggests that the water front owned by the city be devoted to ocean commerce; and that the great business handled by the domestic lines of transportation, and especially by the railways, be required to find its own accommodations.

THE ECONOMIC DEPTH FOR CANALS OF LARGE TRAFFIC.*

By Joseph Mayer, M. Am. Soc. C. E.

In the determination of the most economical method of transportation between the Great Lakes and Europe there are these alternatives to be considered:

1.—Lake steamers on the lakes, barges on the canals and river and ocean steamers from New York. This method offers the cheapest transport on lakes, canals and ocean. It requires only a cheap canal of moderate water-prism between Buffalo and Albany. It is, however, subject to heavy costs of transfer at Buffalo and New York. The delays caused by transfers make this the slowest method. It probably justifies a canal 12 ft. deep.

2.—Barges on the lakes, canals and near sea coasts; ocean steamers for distant sea coasts and foreign trade. This method avoids all transfer in Buffalo, and a large part of it in New York. It gives fairly cheap transport on the lakes, canals, and along the sea coasts, but it is subject to heavy costs for transfer in New York on a part of the traffic. It probably requires a canal 16 to 18 ft. deep to make it most economical.

3.—Ocean steamers for through business between the West and foreign countries or distant sea coasts; barges or lake steamers between the West and the East. This avoids all transfers, gives cheap transportation on the lakes and ocean, but rather dear transportation on canals for through business between the West and Europe. For business between the West and the East it gives the best accommodation, allowing a larger speed for barges and lake steamers. It is the fastest route for all traffic; but it needs not only enormously expensive canals, but also the deepening of lake channels and harbors.

It is evident from the above, that for determining which is the best method the following data have to be obtained:

(a) Cost of canals between Buffalo and New York of, say, 12, 18, 24 and 28 ft. depth.

(b) Cost of deepening lake channels and harbors to various depths.

(c) Cost of transportation in ocean vessels of various draft from 20 to 26 ft. on the ocean or lakes, and in canals and rivers.

(d) Cost of transportation in barges and lake vessels of various draft in canals and rivers of different size, and on the lakes and sea coasts.

(e) Cost of transfer in New York and Buffalo and methods of improving the same.

(f) Probable amount of traffic through canals of various depths and at various freight rates.

Major Symons' report* contains the most valuable collection of data referring to these matters, which has come to the author's knowledge.

There are two kinds of costs incurred in moving freight, cost of transport and cost of transfer. The best possible adaptation of the carrier to the route on which it travels will make the cost of transport the smallest. Canals of moderate depths will furnish very cheap transport if the carriers are especially adapted to them. This best adaptation of the carrier to the route, for the traffic between the lakes and Europe is, however, only obtainable by transfers in New York and Buffalo. These produce large costs of transfer, and slowness of transportation, the latter a disadvantage difficult to be expressed in figures, unless the higher freight rates and larger amounts of business, which railroads are able to obtain, are taken as a measure of it. These costs of transfers can, on the route here considered, be partly avoided by using barges that are able to run safely and economically on the lakes and sea coasts. These barges, however, are not as economical on canals as mere canal barges, because the latter can be built much lighter. These lake barges need also a much deeper and more expensive canal.

Costs of transfer and costs of transport are two opposing factors, of which the first can only be avoided by at least slightly increasing the latter. It is very important to carefully determine what is properly chargeable to each, since an error in this respect must often lead to an erroneous choice between the three methods of transportation above mentioned. It is also important not to neglect the economic value of speed of transport which is largely the cause of the higher rates and larger amount of business obtained by railroads. Since the relative costs of transport and of transfer are so decisive, in the proper choice of method of transportation, Table No. 1 is given and shows the results of a calculation of these amounts, based on Major Symons' Table No. 32, with the assumption that one-third of the expenses of a steamer between Chicago and Buffalo, and of the barges between Buffalo and New York, and one-quarter of those of a steamer between New York and Liverpool, are incurred while in

*Condensed from a paper read before the American Society of Civil Engineers, March 2, 1898.

*Eng. News, Nov. 11, 1897.

TABLE I.—Estimated Cost of Transportation, Chicago to New York and Liverpool, Based on Major Symons' Estimate in Cents per Bushel of Wheat.

	Cost of carrier in Chicago.	Cost, Chicago to Buffalo.	Cost in Buffalo. Transfer charge up, 25 cents per ton. Transfer down, per bushel.		Cost, Buffalo to New York.	Cost of carrier from West, in New York.	Cost Chicago to New York.		Cost of transfer to ocean steamer in New York.	Cost, New York to Liverpool.	Cost of carrier in Liverpool.	Cost of transport, Chicago to Liverpool. Sum of 3, 6 and 11.	Cost of transfers, Sum of columns 2, 4, 10 and 12.	Cost of transfers, Sum of columns 2, 5, 10 and 12.	Cost, Chicago to Liverpool Sum of columns 13 and 14.	Cost, Chicago to Liverpool. Sum of columns 13 and 15.
			Cts.	Cts.			Sum of columns 2, 3, 4, 6 and 7.	Sum of columns 2, 3, 5, 6 and 7.								
			1.3	0.75												
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
By Ship Canal, 24 ft. deep { 5 000-ton vessels...	0.23	0.91	0	0	1.55	0.23	2.92	2.92	2.08	3.93	0.65	6.89	2.96	2.96	9.85	9.85
7 000-ton vessels...	0.23	0.91	0	0	1.29	0.23	2.66	2.66	2.08	3.93	0.65	6.13	2.96	2.96	9.09	9.09
By Erie Canal in present condition { With 4-boat fleets.	0.23	0.91	1.88	1.47	1.95	0.49	5.46	5.05	2.84	3.93	0.65	6.79	5.60	5.19	12.39	11.98
With 6-boat fleets.	0.23	0.91	1.80	1.42	1.77	0.44	5.18	4.77	2.79	3.93	0.65	6.61	5.50	5.09	12.11	11.70
By Erie Canal as it is being improved { With 4-boat fleets.	0.23	0.91	1.67	1.26	1.13	0.28	4.23	3.81	2.68	3.93	0.65	5.97	5.18	4.77	11.15	10.74
With 6-boat fleets.	0.23	0.91	1.65	1.24	1.09	0.25	4.08	3.67	2.61	3.93	0.65	5.87	5.14	4.73	11.01	10.60
1 500-ton barge canal, 18 ft. deep, with semi-independent motive power	0.23	0.91	1.55	1.14	0.68	0.16	3.47	3.06	2.01	3.93	0.65	5.46	4.44	4.03	9.90	9.49
Barge canal 18 ft. deep {	0.23	0.91	0	0	0.62	0.16	1.92	1.92	2.01	3.93	0.65	5.46	2.80	2.80	8 35	8 35
	0.23	0.91	0	0	0.62	0.16	1.92	for freight to and from New York.								
	0.23	0.91	0	0	0.62	0.0	1.76	" " " "				the sea coast.				

Column 8 gives cost from Chicago to New York, with transfer charges in Buffalo as they are at present.
Column 9 " " " " " " reduced to 0.75 cent per bushel
Column 16 " " Liverpool, with transfer charges in Buffalo as they are at present.
Column 17 " " " " " " reduced to 0.75 cent per bushel.
It was assumed that the building of a 12, 18 or 24-ft. canal would produce a reduction in transfer charges in New York of 0.50 cent per bushel

port. Several columns have been added, and corrections made in regard to the cost of transport in lake vessels between Buffalo and New York, and several arithmetical errors, in Major Symons' table, have been corrected.

The canal of 12 ft. depth, recommended by Major Symons, would probably decrease the total cost between Chicago and New York by 2.12 cts. per bushel, or 71 cts. per ton, partly by forcing a reduction in transfer charges in Buffalo and partly by reducing the cost of transport in the Erie Canal. It would probably bring about a reduction of transfer charges in New York for all freight going through it, estimated at 0.5 ct. per bushel. It might do even better if it should prove practicable to build barges of 10-ft. draft, that could run economically on the lakes, canals and sea coasts. This saving would abundantly justify the expense of a canal 12 ft. deep if it were impossible to build one of a different depth that would give a better return on the capital invested. The saving obtainable by a canal on the Oswego route, of 18-ft. depth, and with a water-prism of 2,400 sq. ft., may be thus analyzed: Such a canal could be navigated by barges, which have proved by experience their ability to compete successfully with the cheapest means of transport on the lakes and along the sea coast from Virginia to Maine. They would have to run through 94 miles of canal and 94 miles of canalized river, while the 1,500-ton barges on the canal suggested by Major Symons would have to contend with 270 miles of canal and 73 miles of canalized river. The former would, therefore, do at least as well as regards cost of transportation, and very much better in regard to time. They would also save the transfer in Buffalo. The cost from Chicago to New York for a bushel of wheat would, therefore, be 1.14 cts. less than on the 12-ft. canal (see Table No. 1), or a saving of 38 cts. a ton on all freight to and from New York. If it be assumed that the 12-ft. canal would force transfer charges in New York, which are now for through business, inclusive of trimming, on ocean carriers from 1.7 cts. to 1.2 cts., there would remain a cost of transfer in New York of 2 cts., which would be saved on the 18-ft. canal for all freight going to near sea coast points.

Such a canal, having a smaller amount of contracted channel and avoiding transfers, would also give a considerable advantage in time, especially if the locks at Niagara Falls and at Cohoes could be bunched into two of Mr. Dutton's pneumatic locks in the former, and one in the latter place. The difficulty of obtaining enough water on the summit level could also be solved by using these locks (which need only a small fraction of the water consumed by ordinary locks) in the two locks at the ends of this level. Such a canal, avoiding transfer in New York, would give the whole sea coast from Virginia to Maine the benefit of extremely cheap transport with the West, and would probably secure as much freight from, and to these sea coasts, as from, and to New York.

The saving on the 18-ft. canal, as against the present Erie Canal, would be (see Table 1):

	Per ton.	Cts. per bushel.
On freight to and from New York.....	$1.09	3.26
" " " Europe	1.25	3.76
" " " near sea coast....	1.92	5.76

The average is $1.42 if equal amounts of freight be assumed for the three destinations.

On a business of 12,000,000 tons, which might reasonably be expected soon after the opening of a 12-ft. canal, the saving would be $9,520,000, if it be assumed that one-half of it will go beyond New York. An 18-ft. canal could be navigated by the barges at present existing on the lakes and sea coasts. It would give speedier transport and could give cheaper rates, and would therefore have, from the beginning, a larger business than a 12-ft. canal. If it be assumed that it would obtain a business of 15,000,000 tons soon after the opening, it would give a saving of $1.42 × 15,000,000 =$21,300,000 per year in cost of transport and transfer. It has been assumed, so far, that barges would not cross the ocean. Attempts have been made to build whaleback barges for ocean traffic, but if the author is not misinformed, they have failed on account of structural weakness. There seems to the author to be no doubt that ocean-going barges can be designed that could do business on the lakes, and on an 18-ft. canal, with fair economy; and, with anything near the present transfer charges, they would, probably, have an advantage over other carriers in through business between the West and Europe. There would be no difficulty in designing a proper attachment for the hauling cable to the barge or vessel to prevent its breaking on account of the inharmonious motion of vessel and barge produced by storms. Should a canal of 18 or 20 ft. depth be built between Buffalo and New York, the greatest possible inducement would be given to experiments in this direction, and there seems to be little doubt that they would be successful. In this case there would be much less inducement to build a ship canal for ocean steamers than at present exists.

A canal of 18 ft. depth, with 2,400 sq. ft. of water-prism, on the Oswego route, would probably cost about $100,000,000. A canal of 24 ft. depth, with about 4,200 sq. ft. of water-prism on the same route is estimated by Major Symons to cost $200,000,000.

The result of this argument is altogether in favor of large motorless barges as carriers on routes containing long stretches of canals, and promising a large business, because these make possible the avoidance of expensive transfers with only a slight increase in cost of canal transport.

The reason why motorless barges, fit for sea coast and lake traffic, are almost equally well fitted for traffic in a canal of sufficient depth, lies in the fact that they carry no motive power. The motive power for a vessel at canal speed of 4 miles an hour, in comparison with that required for economical speed on the lakes, say 13 miles an hour, is about one-thirty-fourth of the latter. A carrier containing its own motive power, sufficient for a speed of 13 miles per hour, is very expensive per ton of carrying capacity; it makes up for this disadvantage, however, by its speed, and can thereafter do business on the lakes as cheaply as large barges at much slower speed on canals. Let this carrier come in the canals, where it is obliged to reduce its speed, and it suffers from the combined disadvantage of being very expensive, in comparison with its capacity; of needing a large crew; and its motive power, working at only a small fraction of its capacity, is extremely wasteful in coal, oil and supplies, as well as in attendance on engines and boilers. This is the main reason of the unfitness of either lake or ocean steamers for canal traffic. The motorless barges can be hauled, on the lakes or sea coasts, by powerful tugs at the speed of lake vessels, and on the canals either by steam canal-barges, or by small tugs. The difference in design of lake and canal-barges is small in comparison with that between a vessel able to run 13 miles an hour, and a motorless barge, or a barge fit to run 4 miles an hour and haul a few consorts. Large motorless lake or ocean-going barges, therefore, fulfill most nearly the conditions for cheapest and speediest transport, which are, absence of transfers and best adaptation of carrier to route.

The Secretary read a letter from Mr. Geo. H. Raymond, an elevator owner of Buffalo, in which the plan was advocated of increasing the width of the Erie Canal rather than its depth. He favored a canal large enough for barges of 600 tons capacity and believed that by enlarging the prism the canal could be made large enough for such vessels at an expenditure of not more than $15,000,000. He proposed towing six such barges in a string, and estimated that on this plan the cost of transportation of freight from Buffalo to New York could be reduced to 36 cts. Mr. Raymond also brought forward the argument that for loading steamers in the port of New York, barges of 600 tons capacity would be more advantageous than large capacity vessels.

In another letter the question "who would get the benefit of any reduction in freight rates which would be brought about by a ship canal or an enlargment of the present Erie Canal?" was brought forward. The writer thought the consumer of grains would be benefited more than the producer, and the result would be to give the foreign buyer of American grain a lower price. He therefore believed there was no need of reducing grain rates unless competition with India or other cereal producing countries made it necessary. Maj. Thomas W. Symons sent a written discussion, in which he remarked that his own paper was not to be considered as anything more than a tentative solution of the problem; the figures given were simply a first approximation. He was still firmly of the opinion that a barge canal along the present Erie route was the best plan and he did not consider it feasible to build a ship canal on this route. The 1,500-ton barge canal recommended in his report seemed to him to be as large as would be practicable on the line of the present Erie Canal.

Mr. Mayer's estimate of running time in the various routes appeared to him too theoretical. Sufficient time was not allowed for trips, and the difficulties of transferring in Buffalo and New York were exaggerated. The solution of the problem in the most satisfactory way appeared to him to be lake steamers drawing 18 or 20 ft. and of 7,000 to 10,000 tons capacity, and ocean steamers carrying 15,000 to 20,000 tons and drawing 30 ft. or more, using a canal and barges of proper design as the connecting link. It was safe to assume that an 18-ft. canal would cost twice as much as one of 12 ft. It was possible that in time a 12-ft. canal might be cut across Michigan giving a straight course from Chicago to Buffalo. He was still convinced that the early builders of the Erie Canal had selected the best canal route.

It was stated by one of the members that perhaps Mr. Symons' paper was not known to the members and that the Board of Directors might obtain copies for each member of the Society out of the 100,000 reprints recently ordered by Congress. The chairman announced that the question was already under consideration. Mr. Geo. S. Morison said that most of the grain shipped comes to the seaboard from west of Michigan, and as railway rates to the Eastern and Gulf ports are about the same, cheaper rates of transportation must be secured if New York wished to hold her grain export trade. One thing which will always help New York's export trade is that it is the greatest importing city in the Western hemisphere, and naturally steamers landing there would prefer loading there, notwithstanding the fact that grain could be brought and loaded more cheaply at some other port doing only an exporting trade. It seems that for many reasons 20 ft. may be selected as the limit of draft of lake steamers, a style of vessel that is extremely cheap, both in construction and operation. In the chain of conveyors used in the grain trade between the great West and Europe, regarded from the standpoint of cheapness, lake freighters rank best, then canal boats and finally ocean steamers. Mr. Morison considered the present considerable cost of transfer in Buffalo and New York a matter easy to reform, requiring only some business combination whereby through bills of lading could be obtained. Some of the railways own steamship lines on the lakes and can, therefore, bill freight through from the far end of the lakes to New York. Such a combination between lake steamers and canal barge companies would go a long way toward reducing transfer charges.

DESIGNS FOR THE MASSACHUSETTS AVENUE VIADUCT AT WASHINGTON, D. C.

(With full-page plate.)

In our issue of Jan. 27, we published the competitive designs for the Connecticut Avenue Viaduct over Rock Creek, at Washington, D. C. We show on our inset sheet this week two designs proposed for the crossing of the same stream at Massachusetts Avenue. The wording of the Act of Congress of March 3, 1897, authorizing these latter designs, limited the materials of the structure to stone or steel, and precluded the consideration of concrete arches, or those of the Melan type.

The stone arch bridge was designed by Capt. D. D. Gaillard, Corps of Engineers, U. S. A., in charge of the Washington Aqueduct, after a careful study of the picturesque site of the bridge. The grade line of the proposed roadway is about 89 ft. above the bed of the stream, and about 110 ft. above foundation rock. The total length of the bridge and abutments is 502 ft., and as segmental or elliptical arches of moderate span would have given an unpleasing, stilt-like appearance to the structure, three full-center arches of 100-ft. span each were chosen, with a width of 81 ft. out to out. The arch ring, a part of the pier and abutments, and the facings of the abutment and spandrel walls were assumed to be of granite; the arches were to be backed by concrete or rubble masonry, and the piers were to be granite, with Portland cement concrete. The total estimated cost of the structure was $568,545, including in this 10% for engineering, superintendence and contingencies. This cost is based upon the following item prices: For granite arch-stones, in place, $28 per cu. yd.; rough-faced ashlar and granite backing, in place, $18 per cu. yd.; natural cement concrete, in place, $5; Portland cement concrete, $7 per cu. yd.; rock excavation, $3 per cu. yd.; earth and rotten rock excavation, 80 cts., etc.

The plan for the steel arch bridge was prepared by Prof. Edgar Marburg, M. Am. Soc. C. E., Professor of Civil Engineering in the University of Pennsylvania, acting as Consulting Engineer. This bridge consists of a central arch of 250 ft. c. to c., flanked by half-arches, or cantilevers, of 125 ft. each. The lower chords are parabolic in form, with a rise of 50 ft. at the center and extreme ends of the bridge. The depth, between centers of gravity of chords is 10 ft. at these points, and the extreme height is thus 60 ft., from the springing point of the main arch to the center of the upper chord. There would be three main trusses, spaced 28.25 ft. apart on centers; the bridge would be 80 ft. wide over all, with a 50-ft. roadway and two 15-ft. footways partly supported on brackets. The bridge is calculated for a live load of 100 lbs. per sq. ft. of surface on both roadway and sidewalks. The material used would be medium steel. Sliding joints would be inserted in the upper chords, at the center of the arch, and in both chords between the cantilever arms and the suspended trusses, to provide for variations in lengths from temperature changes. Roller bearings are recommended to make the springing points of the arch more truly hinged. Prof. Marburg points out in his report that as concessions have been made to appearance at the expense of material, there are some uneconomical features in the design.

The estimated total of steel in the bridge is 2,679,400 lbs. Including an asphalt pavement on buckle plates, masonry and foundation excavations, the estimate of total cost is $199,204. Several modifications in the interest of economy are proposed by Prof. Marburg, which would reduce the total cost to $183,304, or to $150,000; but the latter estimate would eliminate nearly all the ornamental features of the bridge and substitute a wooden floor for the steel beams and asphalt paving.

FIG. 7. VIEW OF DAM SHOWING HEART-WALL AND CABLEWAYS.

FIG. 6. VIEW OF DAM SHOWING STEEL PLATES WITH SUPPORTS FOR MOLD.

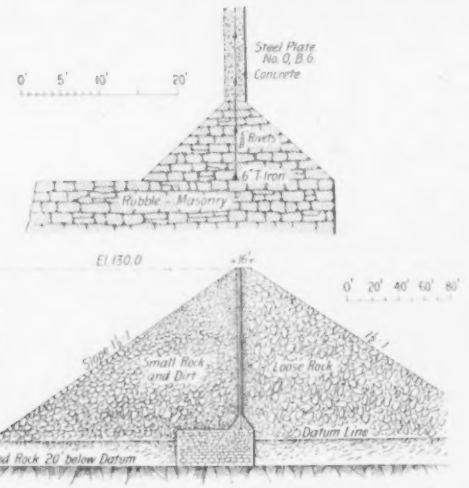


FIG. 4. CROSS-SECTION OF DAM AND ENLARGED SECTION OF STEEL HEART-WALL.

FIG. 1. VIEW OF DAM UNDER CONSTRUCTION.

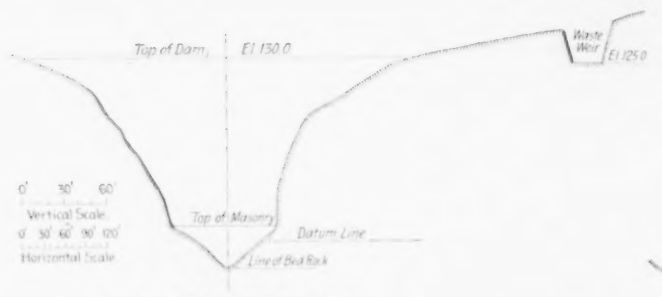


FIG. 3. PROFILE OF DAM.

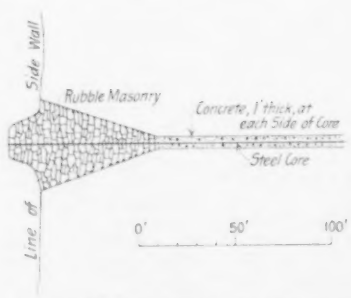


FIG. 5. PLAN SHOWING ENLARGEMENT OF MASONRY BASE AT ENDS OF DAM.

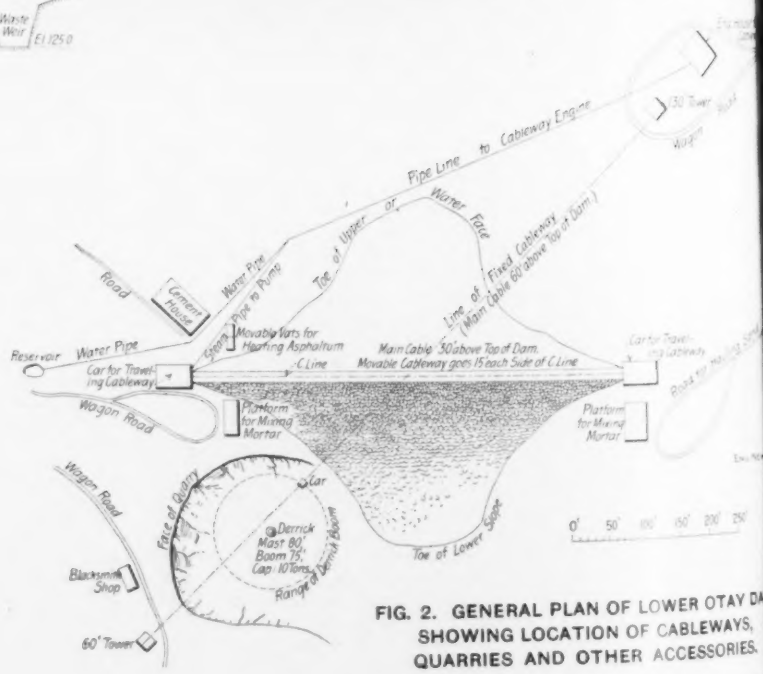
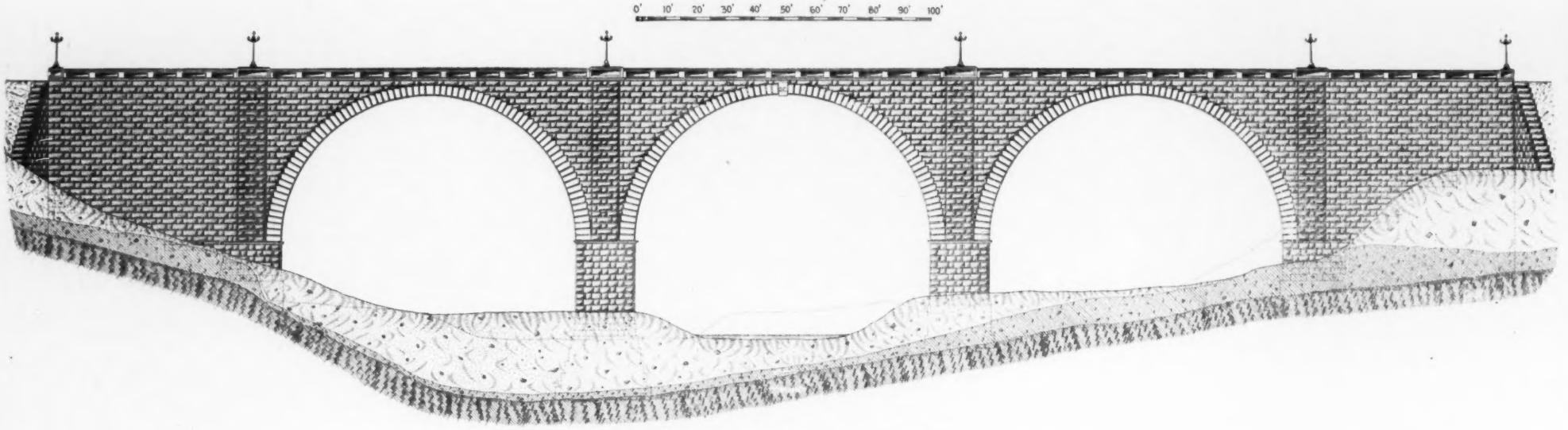


FIG. 2. GENERAL PLAN OF LOWER OTAY DAM SHOWING LOCATION OF CABLEWAYS, QUARRIES AND OTHER ACCESSORIES.

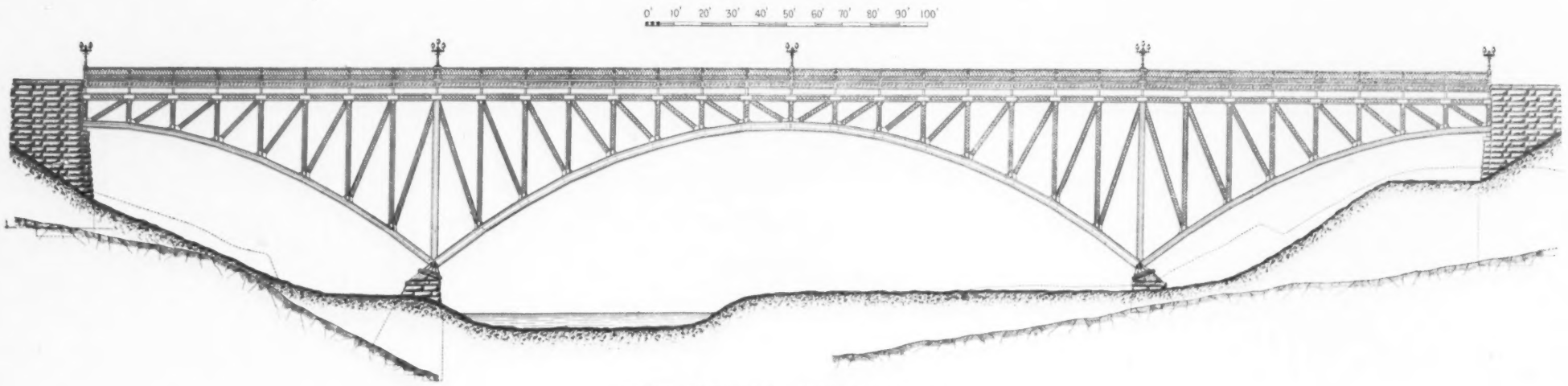
LOWER OTAY DAM.

Southern California Mountain Water Co., San Diego, Cal.

W. S. Russell, Chief Engineer.



DESIGN FOR A STONE ARCH STRUCTURE,
BY D. D. GAILLARD, CAPTAIN, CORPS OF ENGINEERS, U. S. A.



DESIGN FOR A STEEL ARCH STRUCTURE,
BY PROF. EDGAR MARBURG, M. AM. SOC. C. E.

DESIGNS FOR A VIADUCT OVER ROCK CREEK AT MASSACHUSETTS AVE., WASHINGTON, D. C.

A ROCK-FILL DAM WITH A STEEL HEARTWALL AT OTAY, CAL.

By W. S. Russell.*

(With full-page engraving.)

The Lower Otay Reservoir forms one of a chain of reservoirs being constructed by the Southern California Mountain Water Co., of San Diego, Cal. When completed the system will comprise three large storage basins. The reservoirs will be connected, although not on the same stream.

The first reservoir, or the one the farthest from San Diego, is the Morena, at an elevation of 3,000 ft. This reservoir is 45 miles in an air line east of San Diego. Eight miles nearer the city, and on the same stream, is the Barrett Reservoir site, at an elevation of 1,500 ft. The third and last is the Lower Otay, 22 miles southeast of San Diego, and 400 ft. above tide water.

The first two are connected by the Cottonwood River, and the final link in the chain will be the construction of a ditch eleven miles in length that will carry the water from the Barrett Reservoir to the Dulzura Pass, a low ridge that separates the two drainage areas, from where it will reach the Lower Otay by the way of the Otay Creek.

The Lower Otay is the only reservoir completed, although the others are in course of construction. This reservoir will hold when full 14,000,000,000 gallons, will flood an area of 1,000 acres, and is formed by building a dam 130 ft. in height and 545 ft. long at the crest, across a canyon at the lower end of the Janal Valley. This dam is of loose rock, and has a core, or diaphragm, of steel made by riveting sheets of tank steel together, forming a continuous web. This core is protected by a light wall of masonry, the whole being held in place by a mass of loose rock each side of the core.

A general view of the dam under construction is shown by Fig. 1. The general plan of the dam and the machinery used for erecting it is shown by Fig. 2, while Fig. 3 shows the dam in profile. Fig. 4 is a cross-section of the structure, with an enlarged section of the masonry portion and the steel heart wall.

The original plan was to build a dam of rubble masonry, similar to the Sweetwater, only a few miles distant. In carrying out this plan, a trench, or excavation, 65 ft. in width, was made from the bed of the stream to bed rock, a depth of 20 ft. From the bed rock, a dam of rubble masonry was built to a height of 28 ft., making a dam 65 ft. wide and 85 ft. long, as shown in Figs. 3 and 4.

Owing to the amount of excavation necessary to reach the bed rock on the west side of the canyon, the plan of building a masonry dam was abandoned for that of a loose rock dam with a steel core. A narrow cut, or excavation, was made through the loose rock to the solid rock forming the side walls of the canyon. The trench was cut into the bed rock 4 ft. in width and the same depth, after passing through all loose and rotten rock. This trench was on the line of the axis of the loose rock dam, but only 10 ft. above the lower line of the masonry wall.

On the top of the masonry dam and on the line of the center of the trench, a T-iron was anchored to the masonry by 1-in. bolts, leaded fast in holes drilled in the masonry, as shown in Fig. 4.

The T-iron was punched for ⅝-in. rivets, spaced 3-in. c. to c., to coincide with the punching of the steel plates. Part of the sheets were 5 ft. wide by 17 ft. long; the others 8 ft. wide by 20 ft. long, and ranging in thickness from No. 0 to No. 3 Birmingham gage.

The rivets were heated in a small portable forge, and were driven or riveted by two men using 3-lb. hammers, with one man holding a dolly bar on the head of the rivet. A bolt was put in every third or fourth hole, and the sheets hammered and drawn close together before riveting. After the rivets had cooled, they were all examined and sounded to be sure none were burned or cracked, or not riveted as they should be; any found defective were cut out and another put in its place.

After riveting, the edges of the sheets were split and calked; the sheets were so placed that the calking could be done on the water side of the core. All work on the steel was carefully done with a view to making as good a job as would be done on a boiler intended to carry a high pressure of steam.

After calking, a covering of F grade California Alcatraz asphaltum was applied as nearly boiling hot as possible, brushes being used for the purpose. This is a soft semi-liquid grade of asphaltum that will not stand on a vertical surface without flowing. To prevent flowing, a strip of burlap was hung with its center on the top of the steel, and its end reaching about 3 ins. below the top of the next lower course of sheets. The burlap was brushed on while the asphaltum was still warm, with a board used in the same manner a paper hanger uses a brush in smoothing paper on a wall. On the burlap a coat of C-grade asphaltum was applied in the same manner as the first; this last coat makes a tough, hard covering that will stand on a vertical surface even on a warm day under the direct rays of the sun. The burlap was put on immediately after the first coat, but the second coat was not hurried, as the soft coat would ooze through the burlap if left a short time, making a smooth surface for the second covering of asphaltum. If the steel was at all rusty, it was cleaned before receiving its covering of asphaltum.

To protect the steel from injury by rock used in the body of the dam, a narrow wall of masonry (sand concrete.—Ed.) was built up each side of the steel core, as shown in Fig. 4. Commencing with the first course of steel on top of the masonry dam, this wall was made 8 ft. in thickness each side of the core, but narrowed gradually, until, at a height of 8 ft. from the T-iron, it was 1 ft. in thickness each side of the steel. This thickness was maintained from this point to the top of the dam.

To prevent leakage around the ends of the core, the masonry wall was made wider where it joined the bed rock, as shown by Fig. 5. Commencing about 20 ft. from the sides of the canyon where the narrow trench had been cut into the bed rock, the masonry wall would be gradually widened to a width of 20 ft., where it joined the rock side walls.

The masonry wall would be brought up within 6 ins. of the top of the steel before another course of plates was riveted on. The mortar used was made of best English Portland cement, mixed with clean washed river sand. The proportions used were 1 part cement to 4 parts sand for the end walls, and for the narrow wall up to a height of 70 ft.; after this the narrow center wall was made of mortar mixed with 1 part cement and 6 parts sand. The mixing of the mortar was done by men with shovels on platforms at each end of the dam. These platforms were near the top of the dam, and the mortar was sent down in a chute to whatever height it was being used.

To hold this narrow wall of masonry in place until hardened, 2 × 6-in. pieces were set upright 13 ins. from the steel, as may be seen in the view, Fig. 6. One-inch boards were nailed to these pieces, leaving a space of 12 ins. for the masonry. The uprights were set opposite each other and fastened to each other by another piece of 2 × 6-in. stuff, with its edge resting on the top of the steel. On top of this was laid the plank for a runway for the men wheeling mortar from the chutes to wherever it was needed in the narrow wall, as shown in the views, Figs. 1 and 7. The chutes discharged directly on the wider walls on the end of the core.

The steel sheets were not fitted to the uneven rock of the side walls, but brought as close as possible without cutting. In some cases, anchor bolts were leaded into the rock walls and riveted to the ends of the sheets. Where this was not done, short drift bolts of ⅝-in. iron were put through the rivet holes in the end of the sheet, with their ends embedded in the masonry.

To hold this core of steel and masonry in place, loose rock was thrown in each side of it; below the core (on the downstream side) large rock weighing from two to ten tons were used with enough small rock to fill all interstices. Above the core, or on the water side, small rock mixed with the dirt from the quarry was thrown in place. The slopes of this embankment were 1½ ft. horizontal to 1 ft. vertical. The loads were dumped 8 or 10 ft. away from the core, and small rock kept close to the masonry to prevent injury by larger rock rolling against it. The work was kept on as nearly the same level as possible, so as to prevent settling unevenly by a great amount being thrown in one place in a short time.

The rock was brought from the quarry situated on one side of the canyon, just below the dam, by a Lidgerwood cableway, having a span of 950 ft. and capable of handling a safe load of ten tons. The cable on which the carriage traveled rested on two towers, one 130 ft. high, the other 60 ft. high. This difference in height was due to the difference in elevation where the two towers stood. The rock was delivered on the dam by this cableway, and until the dam reached a height of 75 ft. it was scattered to wherever needed by derricks. The length of the dam at this point being so great that it could not be handled without transferring from one derrick to another, another cableway was brought to take the place of the derrick; this was also a Lidgerwood cableway, but the towers were built on heavily ballasted cars, shown in the view, Fig. 7, that could be moved from a point 15 ft. below the core to one the same distance above, with the main cable parallel to the axis of the dam. This type of cableway was used largely in the construction of the Chicago Drainage Canal on the rock sections. The first cableway crossed the dam at an angle of about 60°, the main cable being 60 ft. above the crest of the dam. Cable No. 2 was only 30 ft. above the dam, allowing sufficient room for loads to be carried over this by cableway No. 1. In the quarry a derrick was placed so that a load could be picked up in any part of the quarry and set down directly under the cable. A loaded skip would be handled in the following manner: First, the derrick would pick up the loaded skip and set it down under the cableway, and put an empty back where the load was taken from. Cableway No. 1 would then hoist the load and carry it on the dam, where the chains would be unhitched from this and hitched to an empty skip for cableway No. 1 to take back to the quarry. Cableway No. 2 would then hoist the load, carrying it wherever it was needed, and spill it, and set the skip back before cableway No. 1 was back with another load. In this way the cableways and derrick would all be at work, and yet not get in each other's way. As high as 225 loads have been handled in ten hours, and a daily average of 200 loads has been made for several weeks at a time. The number of loads handled could be increased where the quarry was above the top of the dam. At the Otay, the level of the bottom of the quarry was but 20 ft. above the base of the dam. The time consumed in hoisting and lowering was equal to one-fifth the time taken to handle a load from the quarry to the dam.

The rock was a hard porphyry, was easily broken, but very hard to drill. The first quarrying was done by drilling holes from 12 to 20 ft. in depth for each blast. This was found to be very expensive and too slow. It was decided to run a drift, or tunnel, into the hill, and make a large blast. This was done by driving the drift a distance of 50 ft., and at this point branching, so when completed it would form almost the letter Y. The upper extremities of the Y were enlarged to make the powder chambers. The one on the right-hand side, or towards the dam, held two tons of Judson powder, a low grade nitro-glycerine compound; the other chamber held four tons. The two were connected with wires that were in turn attached to the exploding dynamo used to produce the spark necessary to explode the powder. After the powder was in place the drift was completely blocked with earth and sand. This blast was very satisfactory, as it threw down about 75,000 cu. yds. of rock, and loosened a great deal more than was quarried at a small cost. While this rock was being placed in the dam, preparations were being made for another blast that would furnish rock enough to finish the dam. Instead of a drift, a shaft was sunk to a depth of 115 ft., about 85 ft. back from the quarry, and down stream from the dam. At a depth of 50 ft. from the shaft, two drifts were run in different directions for a distance of 25 ft., and a powder chamber made at each end. At the bottom of the shaft two more drifts were run, the one going farthest into the hill being 35 ft., and the one toward the stream 30 ft. in length; 15 tons of powder was used, the greater part being in the bottom chambers. This blast threw down and

*Engineer-in-Charge Lower Otay Dam; 1665 Union St., San Diego, Cal.

loosened enough rock to finish the dam and leave a great deal loosened that could be quarried at a trifling cost. The quarrying in this way was very satisfactory, as there was always plenty of rock in the quarry for the men and machinery to handle. The breaking up of large rock could be done at noon and night, so the work was never stopped for blasting.

All loose hanging rock on the face of the quarry was knocked down after each large blast, so the danger of rock rolling down on the men while working was much less than it would have been had a small blast been made each day, or when rock was needed. Not a man was killed in handling all the rock used in the dam, and the worst accident was a broken limb.

The cables were found very convenient in handling everything needed, besides rock, in the construction of the dam. Wagon roads were built around the towers, and loads of steel or lumber used on the dam could be taken directly from the wagons and carried by the cableways wherever wanted to be used or stored. Tools from the quarry were taken to the blacksmith shop situated near one of the towers of the stationary cableway. The derrick in the quarry was set in place by the cableway, and could be taken down and moved in a day from one part of the quarry to another. Without the aid of the cable this would require several days, as the mast of the derrick was 80 ft. in length, and the boom 75 ft., and both were fitted with truss rods, the middle strut being 3½ ft. long, making it impossible to drag either stick on the ground.

This derrick was fitted with a 12-ft. bull wheel, operated by a special turning engine. The engine that did the hoisting had double cylinders and double drums. One drum raised and lowered the boom, and another hoisted or lowered the loads. The turning engine being separate from the hoisting engine, the derrick could be swung in a circle while a load was being hoisted or lowered. A load would often be picked up from a height of 20 or 30 ft. above or below the landing place under the cableway, and while the derrick was being swung around the load could be either hoisted or lowered, as needed. The derrick in the quarry was very convenient in loading rock weighing from 500 lbs. to a ton in the skips. It was found that rock of this size was the most expensive to handle, as one piece was too heavy for men to lift and too light to pay to send out with the cableway. The derrick could usually handle rock of this kind and still have plenty of time to handle all the loads.

The work on the dam was finished in August, 1897, and the machinery taken down and moved to Barrett's and Morena. A covering of dirt sufficient to make a good road bed was put on the top of the dam, and the dam now serves as a roadway across the canyon. The waste weir will be 200 ft. east of the end of the dam, and will discharge the water during heavy floods into the canyon about 500 ft. below the toe of the dam.

The outlet is made by driving a tunnel through a hill about 1,000 ft. away from the dam. This tunnel is 1,145 ft. in length, and is lined for the first 500 ft. with 1 ft. of concrete, leaving a circular opening 5 ft. in diameter; from here the water flows through a 48-in. steel pipe, surrounded by 1 ft. of concrete. A forebay was built at the entrance of the tunnel, and the flow of water will be controlled by a 48-in. Ludlow gate at the base of this forebay.

During the winter of 1896-7 the reservoir filled to the 60-ft. contour, making the depth of water 80 ft. from bed rock. No perceptible leakage was noticed at this depth, although it is expected that the water will find its way through the small seams in the bed rock forming the sides and bottom of the canyon. This leakage will be so slight that it cannot endanger the safety of the dam, or cause loss of water great enough to be of any value.

The Morena dam will be of loose rock, with a facing of asphaltic concrete, laid on a base made by laying a dry masonry wall on the loose rock forming the body of the dam. This dam is now in course of construction, and will probably be completed in time to catch the rains of 1898 and 1899.

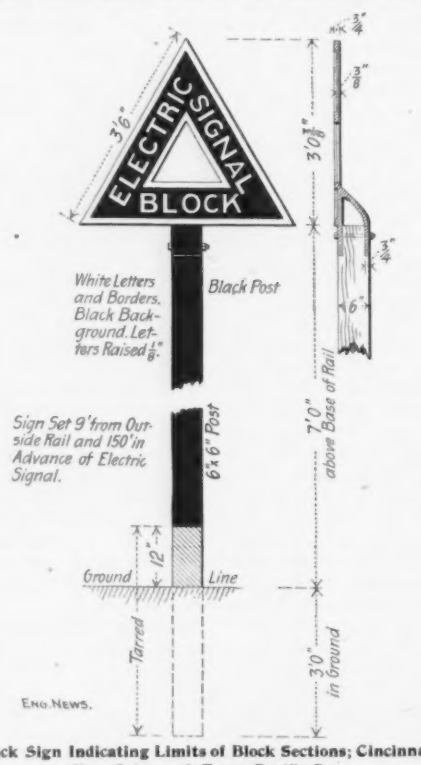
The Barrett dam will be built on the same plan as the Lower Otay. The work done on this dam has only been preparatory. The wall of masonry on which the steel core will start has been built from bed rock to a height of 30 ft. Excavations for bed rock on the sides of the canyon are now being made, and it is probable that work on the dam will soon be commenced.

OPERATION AND MAINTENANCE OF THE BLOCK SYSTEM ON SINGLE TRACK; C., N. O. & T. P. RY.*

By W. A. D. Short.†

There are numerous points to be met and difficulties to be overcome in the maintenance and operation of the block system on a single track railway that are not encountered on double and four track lines. The function of the block system in the latter case is to keep trains (running in the same direction) at proper intervals apart, whereas, on the single track road it must be so managed as to not only protect trains running in the same direction, but in opposing directions. There are numerous ways of accomplishing this, including the telegraphic block, the automatic electric block, the electric train-staff system, and the combination of the telegraphic block and the automatic electric block.

Let us consider the last-named first. In this method, the telegraph block is used for giving telegraphic orders to trains concerning their meeting and passing points, etc., and also concerning the proper spacing of trains running in the same direction, without necessarily blocking until the preceding train has reached the next telegraphic block station. Here the automatic electric block signal comes into play. The second train or section is blocked by the telegraph block, until the preceding train has departed a specified length of time, when it is allowed to proceed and is then



Track Sign Indicating Limits of Block Sections; Cincinnati, New Orleans & Texas Pacific Ry.

governed by the automatic electric block. This block also performs a very important function at meeting points of trains, as it prevents trains from running by their meeting points. The following are a few of the rules governing the operation of trains by this system, as used on the Cincinnati Southern Ry.:

The extreme limits of a block are indicated by a black post with a triangular form, having white letters on the face reading "Electric Signal Block." (Shown in the accompanying cut.) The signal is 210 ft. within the limits of the block.

Trains will be governed by signals on the right side of the track, as viewed from approaching trains.

The signal should be white when the block is clear, change to red when the train enters the block, and before any part of the train reaches the signal, and return to white when a train leaves the block. If a signal is white before a train enters the block and changes to red after the train enters the block, but before it reaches the signal, it indicates safety.

Rule 3.—If the signal is red before a train enters the block, or is white and does not change to red before the train reaches the signal, it indicates danger and the train must stop, send a flagman in advance and in the rear immediately, and then proceed under full control, not exceeding six miles per hour, until the obstruction is reached, or the train passes out of the block.

The above rule demonstrates the vital difference between the single track and the double track road; the red automatic signal on the single track road is absolute, whereas on the double track road the signal is merely a precautionary measure or simply blocks trains a specified length of time. On the single track road the red signal is taken as a warning that a train is approaching the blocked train, and means are at once taken to protect the train.

Rule 4.—Trains of an inferior right approaching a meeting point within the limits of a block, may pass the red signal and proceed to the siding under full control.

This rule shows how the automatic electric signal on the single track prevents trains from running by their meeting points; by stopping the train of the superior right at the signal and causing this train to flag into the meeting point, while it allows the train of inferior right to run to the siding track under full control. The signal serves as a check to the engineman of the inferior train, by reminding him of the meeting point; the train of inferior right being allowed to pass the red signal, under full control, in order to save unnecessary delay.

Rule 5.—When following trains or sections are detained outside of the block each train or section will allow the preceding train or section 5 minutes to clear the block where the block is continuous. If the block is not clear at the end of five minutes, the train will proceed under full control, expecting to find the block occupied by a preceding train.

The flagging rules pertaining to the automatic block should be rigidly enforced, as trains on a single track must protect against opposing as well as following trains. To facilitate the flagging of these blocks and save delay, every passenger train is equipped with a three-wheel hand car. This car is placed in the baggage car of the train and is equipped with suitable brackets for carrying red flags by day, and red and white lights at night.

There are two methods of automatic electric blocking: (1) The isolated block, in which simply a portion of track is protected by two signals; (2) The continuous block, which is a series of consecutive blocks. The normal position of the signals is safety, and they assume the danger position only when the block is occupied. The method of operation is similar to that of all of the well-known automatic electric disk signals, the track circuit being short-circuited by the train and the line circuit in turn broken by the opening of the relay contact points.

On a single track road there is one point to be guarded against that is not met with on the double-track system, namely, the danger of two trains in opposing directions entering the block at the same time and each receiving a safety signal. To obviate this, a preliminary section of track in the isolated block is electrically connected to the signal of the opposite end of block, the object of this being to have the train set one signal of the block at danger before it sets the other one, when going in one direction. In the continuous block system, this preliminary section is called the overlap, because it is "an electrically connected section of track adjoining a block which is one of a series of blocks." The location of these preliminary sections is largely determined by local conditions, such as grades, curves, etc., the preliminary section being connected to the signal governing trains running down the grade. These preliminary sections extend beyond the block proper some 1,500 to 2,000 ft.

In order to save unnecessary delay when trains are stopped within block limits and it is necessary to send out a flagman, the location of the preliminary section is designated by a small battery chute painted white and situated on the engineman's side as he approaches the block which it governs. The location of the overlap is also designated by large battery wells and relay posts painted white, and the number of the signal controlled by the overlap painted on this post. The number is located on the opposite side of the post from the signal controlled thereby, so that the engineman, when he sees this number in front of him, understands that when the front wheels of his engine pass the numbered post, the signal of that number is set at danger. On the other hand, when the number is seen from rear end, the flagman understands that, as the rear end of the train passes this post, the signal of that number is released or allowed to go back to safety. The overlap extends about half a mile into the consecutive block.

This system of marking enables the trainmen to ascertain what signals they are holding at danger, and the flagman may go back to the proper signal and inform approaching trains as to cause of the signal being at danger. At all switches in this block system, switch bells or annunciators are located; these being placed directly behind the switchstand headblocks. The object of these bells is to warn trains on sidetracks when trains are approaching on the main track and also to warn trains in taking the sidetrack as to whether or not they are in the clear.

On the Cincinnati Southern Ry., the electric blocks are divided into sections, each averaging 14 electric signals and about 30 miles in length. Each section is in charge of an inspector, whose duty it is to visit all of his signals, and mechanism pertaining thereto, during the day. He must also keep up all the signal batteries, crossing alarm batteries and switch annunciator batteries. In addition to this, he must keep the telegraph line and circuits clear from local disturbances. Extra men are furnished for any

*Abstract of a paper read at the Pittsburg meeting of the Railway Signaling Club, March 8.

†General Foreman of Signals; New Orleans & Texas Pacific Ry.

heavy work, such as the installing of new signals and reconstruction of old ones.

The batteries principally used are the common gravity batteries. The batteries of the track circuits are replenished, on an average, every 14 days and the batteries of the line circuits, on an average, every 42 days. The cost of maintenance per signal per year is about $88.80.

Difficulties and Failures.—On this line, the principal cause of failures (and one that has not as yet been successfully coped with economically) is lightning. Other failures are due to cracked battery jars and crossed line wires, both of which are not derogatory to the system, but may be classed as unavoidable. Outside of these, distrubances of the track circuit may be mentioned, including loose bonding wires or rivets, leakage in underground wires, and leakage due to track being constantly covered with mud. All of these have been contended with. Loose rivets of bonding wires may be overcome by using extreme care in driving the rivets to see that they go in true and are not driven down so far that they will rebound. The hole for rivet should be drilled far enough from the edge of the rail base to prevent the rivet from going through the rail and thus coming in contact with the ties when the latter are respaced and when the rails creep. Bonding wires should be placed between the angle bars and the web of the rail, as they are then fully protected and are entirely out of the way of trackmen.

When the signals were first erected, it was the habit to put all the underground wires, at any one track section, in the same groove of grooved lumber. This was found to be very detrimental, as the leakage of the underground wires of the same track section would form a short circuit, the relays would remain demagnetized and the signal stand at danger. At certain points in extremely wet weather, this underground leakage would cause the relay to remain magnetized and the signal to stand at safety when the train had entered the block, on account of the battery of one section leaking into the circuit of the other.

This can be overcome in three ways. The first and best method is to replace all underground lumber and provide a separate groove for each and every wire, and make the lumber as weather-proof as possible, by thoroughly painting with an insulating compound or with asphaltum. The second method (and the best for emergencies) is to place a relay in the circuit of a higher resistance than the one in service. This increases the resistance of the circuit to which the current from a lower resistance circuit is leaking. The third method is to use lead-covered wire for all underground work. Ordinarily insulated wire is not impervious to the action of water and clay, as the insulation soon decays and falls off. This seems to be specially the case in damp (clayey) limestone soil, the chemical action probably developing a calcium hydrate, which tends to decompose the braiding and rubber that constitute the insulation of the wire. When lead-covered wire is used, it is not necessary to run this wire in grooved lumber the whole distance, but simply put it in lumber where the wire runs through the ballast to track connections. The wire outside of the ballast line may simply be laid in a trench in the ground, and this, of course, constitutes a great saving in the cost of underground lumber used. The Weber insulated joint gives excellent results, as it holds the track in line and surface far better than the old method of using wooden splice bars, and, consequently, end posts do not cut out as quickly as they did under the old method. The insulated properties of this kind of joint are, theoretically speakir not as good as those of the old wooden splice bars, but for all practical purposes they give excellent results.

Electric Train-staff.—This is an excellent method of handling traffic over a single track that is congested between certain points where speed rate is low. For description of this system, I quote from our book of rules:

The staff is a steel pipe 22 ins. in length, encircled with brass rings, the end of which is stamped with the names of the two points which bound the limits of the block.

This staff performs two duties: (1) It is a key to unlock the levers which operate the semaphore blades, so as to permit the semaphore signals to be set to an inclined or safety position for trains to proceed. (These signals cannot be set to the safety position without first being unlocked by the train staff. (2) It takes the place of, and has the same effect as, a written train order, as the possession of the train-staff by the engineman, conductor, or both, gives to them the absolute right of track through the block against all trains.

Only one staff can be taken from the instrument at one time. When the staff has been withdrawn from one instrument, another cannot be withdrawn from either instrument until the staff previously removed has been placed in the same instrument or in the instrument at the opposite end of the block.

The staff machine is a mechanically-operated machine that is unlocked electrically, by means of magnets. When the magnets of the machine are energized, they attract a locking dog which releases the staff and allows it to be taken from the machine. The action of taking the staff from the machine reverses the current governing that machine, and the one at the far end of the block, doing this by a series of cam movements, so that the currents of both machines work against each other and the magnets of neither can be energized, as the currents at each end of the block are of the same polarity. The replacing of the staff in either machine causes the current to flow through its normal course.

In order to handle trains quickly that are running in the same direction, as in the case of light engines, freight or work trains, there is connected with these machines a permissive staff; and when this is withdrawn from the trains to follow one another, by giving to each train a tablet instead of the staff. The staff of the permissive attachment is very similar to the ordinary staff, but it has an extra large ring on one end, which necessitates its being placed in the machine so that the tabulated end is opposite to the ends of the other staffs. There is only one permissive staff; and when this is withdrawn from the machine, it is used as a key to unlock a box on the side of the machine which contains the tablets. There are six of these tablets, about 7 × 1½ ins., made of ¼-in. cast iron.

The tablets have the names of the places bounding the block limits stamped on their sides, and the sides are painted different colors, generally red and black. When it is desired to run trains close together in sections, each section is given one of these tablets instead of the regular staff. When the tablet is given to the engineman, it is held so that the name of the block limit, towards which the train is moving, is seen by the engineman. Thus, the tablet takes the form of an order to the train that it has the right of track from "A" to "B" against all opposing trains. This is also done with the regular staff. The last train or section receives the permissive staff, and the remaining tablets (which are locked to the staff by a small chain passing through a hole in the end of the staff and the ends of the tablets). It is necessary that all these tablets and the staff be inserted in the same machine before another staff can be withdrawn from either. If any of the tablets are withheld, the currents remain reversed, preventing the permissive staff from being inserted in the machine on account of the dropping down of the locking dogs.

This permissive attachment must never be used for passenger trains, as they should have absolute control of the block. The method of governing trains is as follows: Enginemen of light engines will be given the full staff; passenger, freight and work trains will be given the divided staff. That is, half of the staff will be given to the enginement and the other half to the conductor or foreman of the train. On arriving at the other end of the block the staff, or divided staff, thus given to trains, must be delivered by the engineman and conductor, or foreman, to the operator. The object of the divided staff is to make absolutely sure that the whole train has passed out of the block limits when the staff is delivered to the operator, it being of course necessary to replace a whole staff in one of the machines before another can be withdrawn.

When the operator receives permission from the other extremity of block to withdraw a staff, he stands at the side of the machine, grasps each of the protruding ends of the staff and draws it up perpendicularly and then towards him, the staff being guided by grooves in the machine. After the staff has been withdrawn from the cam movements, it is slid out of the front of the machine through a longitudinal opening. The key end of the staff is then inserted in the locking box placed over the locking (of the mechanical interlocking machine) of all signals governing the approach to the block. It is then turned sharply to the right and releases a spring "dog" which in turn releases the lever controlling the semaphore signals. The staff is then withdrawn and is divided. It is constructed in two pieces, one end having a brass projection with a small iron pin on one side, and the other end having a sleeve with a groove running half around one side and straight down the center, to receive the pin. One end of the staff is held firmly in the left hand and the other end is turned to the left until the pin reaches its groove; then the ends are drawn apart and the parts is ready to be delivered to the engineman and conductor.

The engineman and conductor, or foreman, of a train are the only persons authorized to receive a train-staff or tablet from the signal operator in charge, who must personally hand it to the engineman and conductor, or foreman. On arrival at the opposite end of the block, the engineman and conductor, or foreman must promptly deliver the staff or tablet to the signal operator, but the operator must never receive the staff from conductor or foreman of the train, until the last car has passed the signal or is clear of the main track. In case a train parts, or it is necessary to double, the train staff or the tablet must be retained by the engineman, conductor, or foreman, until all of the train is clear of the block.

Under no circumstances must a staff or tablet be transferred from one train to another. They must be delivered to the operator and the operator must pass them through the instrument and deliver them to the engineman and conductor or foreman, in strict compliance with the rules.

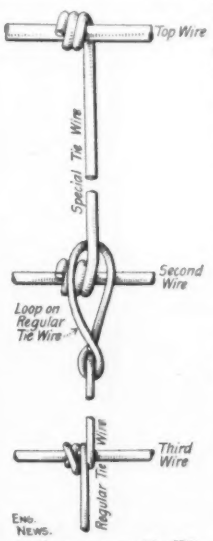
The one drawback to the train-staff system on the main line is principally due to the fact that it is almost impossible for trains running at a high rate of speed to procure the staff or tablets. It can be readily seen that there would be a great deal of delay to fast trains by slowing up at block limits to procure staff. This has been overcome to a certain extent in England* by equipping the engines of express trains with a device similar to a mail catcher for exchanging and delivering the tablets, but the staff itself cannot be exchanged at high rate of speed. When this is overcome entirely it will be an excellent method of handling traffic under all conditions.

It may be of interest to supplement Mr. Short's paper by a few notes on the use of automatic electric block signals on the Cincinnati, New Orleans & Texas Pacific Ry. They were first introduced in 1891, being used to form individual or isolated block sections at some of the tunnels, and since then their use has been gradually extended. By the end of 1897 there were several sets of consecutive blocks at different parts of the road, while 27 tunnels were protected by these signals. There were then about 132 miles of line operated on this system, with about 160 signals, the length of the block sections varying from 1 to 3½ miles. Consecutive block sections overlap, as described in the paper. The signals are mainly of the enclosed disk or "banjo" type, and have been supplied by the Hall Signal Co. and the Union Switch & Signal Co. The latter company has also supplied some clockwork "banner" signals, in which the disk or banner revolves on a vertical spindle. The disk is operated by a train of gearing by means of a suspended weight which will operate the signal for a considerable time, but which in practice is wound up daily by the lamp man. As the electric circuit is opened or closed it locks or releases the gearing. The signals cost about $400 to $500 each, erected, and the maintenance averages $7.40 per month per signal. The failures have averaged only one to about 3,530 signal movements.

*Train-tablet catchers are used in Great Britain and in Australia, as described in Engineering News, in 1894.—Ed.

AN IMPROVEMENT IN WIRE FENCING.

The accompanying cut represents the new stiff connection used between the top wires of the Page wire fencing, manufactured by the Page Woven Wire Fence Co., of Adrian, Mich. This fence consists of horizontal wires tied together by vertical wires, forming a rectangular mesh. The wires are coiled around a mandrel and then straightened out, so that they have an initial spring which serves to allow for contraction and expansion without causing the fence to sag or to be strained too tight. One trouble with this fence was that if it was continually climbed over, or if animals habitually stood with their heads reaching over, the soft tie wires between the two upper horizontal wires would become bent. This gave the top wire the appearance of sagging, and spoiled the appearance of the fence, though it did not impair its effectiveness. To remedy this, the two upper wires are now connected by independent tie wires, and the upper end of each of the tie wires for the other horizontal wires is made with a loop embracing the independent top tie wire. By this arrangement, the two top bars can be borne down to a considerable amount without affecting the lower part of the fence, and will return to their original position when the strain is removed.



An Improvement in Wire Fencing.
Page Woven Wire Fence Co., Makers.

THE DESTRUCTION OF THE PALISADES, along the Hudson River, is progressing. On March 3 "Indian Head," a picturesque, isolated rock, about 200 ft. high, opposite Fort Washington, was blown down by the explosion of a charge of 7,000 lbs. of dynamite. The work was done by Carpenter Bros., who broke up the rock for macadam paving purposes. Two tunnels were driven; one near the water edge and 65 ft. deep, and another about 60 ft. from the top and 80 ft. deep. Two 25-ft. shafts were sunk from the upper tunnel, and drill holes were sunk in addition on the rock. The explosives were divided between these two tunnels; 3,000 lbs. in one and 4,000 lbs. in the other. The estimated weight of the rock broken loose is about 350,000 tons.

THE ATLANTIC AVENUE AND EAST RIVER TUNnel project, having met with defeat at Albany, is now proposing to make a direct application to the New York Rapid Transit Commission for authority to tunnel the river and operate the road. The claim is made that such a proposition comes within the powers of the commission, as the road in question would provide a desirable means of rapid transit from the lower part of Manhattan to the suburbs of New York city, of which Brooklyn is now a part. The plan does not involve a dollar of expenditure for the cities.

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A case of great interest to water companies and to cities wishing to change from private to public ownership of water-works, is now in progress in connection with the water-works of Newburyport, Mass. The point involved is whether the city, which has taken possession of the works of the Newburyport Water Co., can escape paying for the franchise of the company. In 1893 the city secured permission from the legislature to build works. In the following year the company, which built works in 1881, sought legislation compelling the city to buy its plant before building one of its own. It was successful, but the mandatory act provided that the city should not pay anything for the franchise of the company.

On Feb. 1, 1895, the city took possession of the company's works, and subsequently a commission was appointed and made a valuation of the actual property of the company. The commission stated that it had not included the value of the franchise, in accordance with the legislative act, and leaving the court to confirm or amend the award. The lower court confirmed the award, refusing to add anything for the value of the franchise, and the Massachusetts Supreme Court upheld the decision. The case was taken to the U. S. Circuit Court by the company. The city filed a demurrer, urging various reasons why the case should not be tried. The court has overruled the demurrer, holding that if the company can prove the allegations in its bill it will be entitled to relief in equity, apparently under the constitutional provision that private property cannot be taken for public purposes without due process of law.

Whatever may be the outcome of this case, or whatever opinion one may hold as to its merits, it is certain that it is for the interest of all concerned to recognize at the start that franchises are the property of the people and should be reserved for them; in other words, leased, not given away. For some years past we understand that the Massachusetts legislature has been recognizing this principle when passing acts incorporating new water companies, always providing that the municipalities may at any time buy the works at the actual cost of construction, plus the difference between the interest on this cost and the earnings of the company, it being expressly stipulated that nothing shall be allowed for the franchise, except the actual cost of obtaining it. Under such provisions as these each side knows exactly where it stands.

Somewhat allied to the Newburyport case in principle is an act which in one form or another has been introduced in several state legislatures during the last few years. Sometimes it applies to water-works, sometimes to lighting plants, and again to both. Such an act has been introduced every year in the New York legislature for the past five years, but thus far has failed to pass. This year the act is more sweeping than ever, as will be seen from the following reprint of it:

An act to amend the general corporation law, constituting chapter 35 of the general law.

Section 1. Section 11 of chapter 687 of the laws of 1892, entitled "An act to amend the general corporation law," constituting chapter 35 of the general laws, is hereby amended by adding thereto a subdivision to be known as subdivision 6, to read as follows:

6. Whenever any corporation shall be in the possession of or entitled to any rights, privileges or franchises within the limits of any municipal corporation and shall be engaged in the exercise of the same or any part thereof, the municipal corporation within whose limits such rights, privileges or franchises are owned or exercised, shall not itself undertake to perform, within any land or territory, within which such corporate rights, privileges or franchises are or may be owned or exercised, the business or purposes to which said corporate rights, privileges or franchises relate, without first acquiring, in the manner prescribed by chapter 23 of the code of civil procedure, the rights, privileges and franchises of said corporation or to which said corporation is or may be entitled, and also the property of said corporation used in or necessary for the use or exercise of any of said rights, privileges and franchises.

This act shall take effect immediately.

It will be seen that this applies to all classes of municipal works operated by franchise companies. A significant fact connected with such legislation, actual or attempted, is that it does not shut out competition by private companies, but applies to municipalities only. Curiously enough, the New York courts have refused to interfere with municipalities which have undertaken the construction of water-works plants in competition with private companies, while in Pennsylvania such construction has been prohibited by the courts.

A bill somewhat like that given above has failed once or twice in the Pennsylvania legislature. Whether it finally passed or not we cannot say. Perhaps it is no longer necessary since the above-named decisions were rendered. In Massachusetts a few years ago a bill giving cities and towns the right to build municipal electric lighting plants was vigorously fought by the companies, and finally loaded down with provisions that such action could not be taken until two or three different votes, at intervals, had been cast in favor of it, and then if there was a private plant in existence the city must buy it if the company offered to sell it to the city, although the city could not compel the company to sell. All these things tend to show the chaotic state of much of our legislation, the many points not yet settled by the highest courts, and the fact that both municipalities and companies have much to learn before they can put their respective interests on a safe and proper footing.

The injustice of making private water consumers pay for water used for public purposes, such as fire extinguishing, street sprinkling, and the supply of public buildings, instead of raising the money to pay for water used in this way by a general tax, is admirably shown by Mr. Joel Foster, Superintendent of water-works at Montpelier, Vt., in his last annual report. He has taken the trouble to make some very interesting computations which show that the wealthiest property-owners pay much less for fire protection than their poorer neighbors. In Montpelier, previous to 1897, $2,300 yearly was raised by general taxation towards the expenses of the water department. In that year no appropriation was made, the total expense for the works being met from individual water rates. This resulted in payments corresponding to 0.036% on their assessments by persons having property assessed at $10,000 or more; 0.05% on property assessed at from $5,000 to $10,000; and 0.092% for all below. A man worth $4,000 paid, in the average, about the same amount towards the public service as a man worth just over $10,000. Of course this is all wrong, but scores of cities throughout the country refuse to make any appropriation, or make inadequate ones, for water used for public purposes under municipal ownership; and where water-works are owned by a company, little care is taken properly to divide the expenses of the water department between public and private consumers.

The garbage controversy at New Orleans has been closed by the transfer to the city of all the plant of the Southern Chemical & Fertilizer Co., except that pertaining to the Simonin system. The terms of the settlement were briefly outlined in our issue of Jan. 27, 1898, and the controversy itself, or its earlier stages, in our issue of Oct. 8, 1896, in connection with a description of the Simonin reduction system at New Orleans and Cincinnati. The trouble at New Orleans is one of many illustrations of the unsatisfactory condition of garbage disposal in the United States, a subject discussed editorially in Engineering News of Nov. 11 and 25, 1897.

The great bone of contention at New Orleans was the separation of ashes and garbage, which the contract plainly required. At first the company did not insist on this, and when it did so insist, the storm of protest was increased in strength and violence by the fact that the people had just awakened to some appreciation of the manner in which their interests had been neglected in the garbage contract and sewerage franchise passed by previous councils. An attempt was made to annul each of these contracts and each company went into the hands of a receiver, where it still remains. The garbage matter having been settled by a change to municipal ownership, there is some hope that the same solution of the sewerage difficulty may follow. Some of the bad points in the sewerage franchise and the undesirability of entrusting sewerage to private companies were pointed out in our issue of May 20, 1897.

The Simonin reduction plant at New Orleans was virtually abandoned by the company long before the city took the collection of garbage into its own hands. The company claimed that this was made necessary largely by the failure of the people to separate ashes and other refuse from the garbage. As this matter of separation precipitated the struggle, naturally the city has not bought the Simonin plant with the other equipment of the company. It does not follow from this that the Simonin reduction system was a failure, but the incident does show the friction that may be caused in any city where separation is demanded. The city of New Orleans is now dumping its garbage into the Mississippi River, having obtained permission to do so for a year or more to come.

Chicago and Milwaukee have been experiencing difficulty of late in the letting of garbage disposal contracts. Each city awarded a contract not long ago, but the successful bidders failed to execute the contract. Just now a garbage investigation is going on at Milwaukee, and various stories are afloat reflecting on the methods employed there. Rochester and Syracuse have had very unpleasant experiences in attempting to establish, through contractors, satisfactory reduction systems. Newport, R. I., Indianapolis, Ind., and Utica, N. Y., each contracted, or agreed to contract, for garbage disposal some time ago, but the contractors failed to fulfil their agreements, never even beginning construction. Many other cases might be cited where strange delays have occurred in awarding contracts, or contracts awarded have been rescinded by cities, all with no apparent reason other than a conflict between the friends of different furnaces or reduction processes. What is needed is less politics and more engineering and business in this matter.

Under the age limitation, the term of office of Commodore E. O. Matthews, U. S. N., as Chief of the Bureau of Yards and Docks, has now expired. The events of the past few weeks make the government and the people of this country keenly feel the results of past inefficiency in the administration of the business of this bureau, and the whole community is deeply interested in the technical training and general fitness and ability of the successor to Commodore Matthews. Owing to blunders, which an efficient head of this bureau would have avoided, one of the two large dry-docks on our Atlantic coast is structurally weak; and the other one is so located that it is inac-

cessible to the very class of vessels it was built to accommodate. We now have a large modern navy mobilized on this coast, and coming events demand that these vessels be maintained in a condition of the highest efficiency. Dry-docks are imperatively needed for this service, and the authority was granted and money appropriated to build them some years ago. But some one blundered, and our battle-ships can not be docked. To say that these results indicate a lack of businesslike methods in administration in the bureau charged with designing and constructing these docks, is to put it very mildly. In a private corporation, failure of this kind would be classed as criminal—at least, by the defrauded stockholders.

The official head of the Bureau of Yards and Docks should be one of the most important and trusted technical advisers of the government; and his office demands the maximum of personal training and ability in his profession, for in all matters pertaining to his office, his advice and opinions must necessarily have weight with the other members of the government, for he alone is supposed to know of what he speaks. To appoint as the head of this bureau a class of men who do not even pretend to this knowledge, and yet to give them unlimited authority over engineers, is the extreme of public folly; and events prove it. The government should at once stop spoiling a good line officer by attempting to make of him a bad engineer. In this position the best interests of the government demand a lifetime of study, experience and practice in a particular profession, entirely foreign to the duties of a line officer of the Navy. To assume that an elderly line officer can acquire all this knowledge simply by virtue of a commission appointing him Chief of the Bureau of Yards and Docks is nonsense. The government has given a long trial to the latter method; and under modern and much changed naval conditions, the plan has resulted in dismal and disastrous failure, and the practical demoralization of the Civil Engineer Corps of the Navy. Public interest now calls loudly for a change of policy. The lesson of to-day should bear fruit in a wiser administration of the affairs of this bureau through the appointment of a chief fitted to perform the duties of his office.

In our columns of "Trade Publications" last week we made note of a pocket memorandum book issued by the Smillie Coupler & Mfg. Co., of Newark, N. J. The company asks us to state that they have had such a great number of applications for this book as a result of our notice that they are obliged to restrict its distribution to railway officials.

TERMINAL FACILITIES OF THE PORT OF NEW YORK.

In another column will be found some criticisms upon the plans proposed by the board of consulting engineers to the Dock Department of New York for facilitating the interchange of goods between ships and systems of land transportation at that port. The board of engineers believes that this can best be done by a four-track surface railway along the line of the docks on West St.; and the critics assert that the operation of such a railway would be practically impossible, owing to the bulk of the traffic to be handled, and the number of different corporations interested in distributing this traffic and their conflicting interests. In fact, the critics say that such a railway would be of little use, and that its work is more expeditiously and economically done under the existing system of water transportation and distribution to ships. A point prominently brought forward in this discussion is the part now played by the broad and deep North River as a freight yard in loading, unloading, and even in assembling trains. According to the figures given cars enough to make up about 23 railway trains, 1,400 each in length, go westward from New York each day, crossing the river on floats. This is an aggregate of over 6 miles of freight cars and engines, bound for all parts of the United States, and loaded with goods of the most miscellaneous and varied character. To unload and load again these cars on the New Jersey side of the river would add enormously to the cost of transport and to the tax upon present facilities for crossing the river. It would be commercially impracticable. But to perform this same work expeditiously and economically on the New York side, presents a problem that is evidently most difficult of solution, and is one on which the experts widely disagree. The physical conformation of Manhattan Island is an awkward one for combining systems of water and land transport, when a large volume of freight has to be handled. Its position between two navigable rivers, is at once an advantage in providing dock space; and a marked disadvantage when it comes to the land service of these docks. No direct communication between the docks and the trunk railways is possible except by a railway line parallel to the river, or rivers, and much limited and interfered with in operation by the demands of local commerce. An elevated system, which would avoid the street traffic, would add largely to the cost of handling goods, by reason of the difference in level between it and the streets, and it would cost much more to connect any such system either with the piers or with warehouses.

In fact, there are two very different sides to the problem of handling freight coming to and leaving this Island of Manhattan. One relates to the transfer of goods to or from ships, and has to do with foreign commerce; and the other is the domestic commerce, resulting from the position of New York as a vast consumer as well as a distributor of materials of all kinds. If this traffic could be properly divided, as to centers of receipt and distribution, the problem would be much simpler of solution. The board of consulting engineers apparently had some such ultimate division in view when they appropriate to the North, East and Harlem Rivers different classes of traffic, such as are best adapted to the physical conditions and positions of these rivers. But the difficult point is that the North River does handle a large amount of both classes of goods, and apparently will continue to do so; and while separate freight yards on land, combined with landing stages for floats, would, as Mr. Morison suggests, economize water front, it seems that the natural conditions will still require a larger dependence upon floats and barges than upon railways, for all purposes of transfer between cars and ships.

Railways along the water front would be of little use in handling the freight consumed in New York, or in shipping to domestic points goods distributed from or made in New York. The lack of available space for loading and unloading, and the difficulty of adjusting the very varied interests involved were pointed out by Mr. Buchholz, in connection with the business of the Erie Railway Co. And Mr. Katte remarks that the business of the New York Central R. R., West St. down to Canal St., is so hampered by the street traffic that it is continued simply as a convenience to business already established, and not because it is directly profitable to the railway company. The great supplying and distributing lines of railway, West and South, are separated from New York by a broad and deep river, across which goods must be transferred. Even future railway bridges across this navigable stream must be so high above the water surface as to always be handicapped by its grades, and by the cost of real estate, in materially aiding in cheapening distribution for domestic purposes. The cars may be thus brought directly to the New York side, and unloaded and loaded there; but comparison in cost with existing methods will always decide the manner of transfer adopted in this handling of goods; and what profit there may be in such North River bridges would have to come very largely from the handling of passengers and from the enlargement of the residential zone of the workers of New York.

As to goods for export, those of a bulky nature now largely reach this port by barges, and a large part of that which comes by rail cannot go to the ship at once, but must be stored for a time until the markets and vessel rates cause its movement. In this service of distribution to ships, scattered along the many miles of New York water front, the broad rivers must necessarily play an important part. This expanse of water may be likened to a great distributing yard with thousands of tracks, and no switches or frogs; these tracks lead to every accessible foot of water front and alongside every ship, whether this ship is in the North River, the East River, or anywhere in the harbor. The barge or coastwise craft can come alongside the foreign vessel, and either directly, or by means of floating elevators, transfer its cargo. As the docks are arranged at present, these local freight-carriers take up space, and sometimes interfere with the movements of neighboring vessels. But this is a question of dock arrangement and slip-space; and trains of cars on the piers, with their necessary appliances for loading and unloading, would also require space which the steamship companies seem to consider more valuable for the temporary storage of goods than that in the slip, if we can judge from the practice of the North German Lloyd Co., at its Hoboken piers. It is difficult to see, under the controlling natural conditions, how this handling of foreign freight by water can ever be supplanted by any system of surface railways on Manhattan Island at least; and for the reasons pointed out by Mr. Buchholz, the combination of such a railway with the large landing slip, common to all the corporations using car floats, would introduce new elements of confusion into the traffic.

In the convenient and economical transfer of freight from railways directly to ships, that port will always have a natural advantage which has its docks in direct communication with the contributary railway systems, and has ample room contiguous to its docks for all the plant necessary for economically transferring the goods and assembling the trains. This is an impossibility in the port of New York, either on Manhattan or on Long Island; and the west shore of the North River is in another state, and its shallower waters would require expensive dredging to fit it for use.

But to New York the maintenance of its commercial supremacy is an all-important proposition; and the volume of commerce which it can still claim and its natural position warrant every effort it can make toward holding and increasing its foreign and domestic trade. A deeper, straighter channel to the sea, and more larger docks are a first essential, and these will doubtless be secured in the near future. But it is not creditable to this port that only one of its grain elevators and storage depots is approachable by a steamer of any considerable draft. Its commercial dry dock facilities are limited, and in appliances for expeditiously and cheaply handling cargoes we can learn much that is valuable from Liverpool and other great foreign ports.

Again, it appears to us that there is discernible somewhat too great a tendency to limit the development of the port by artificial political boundaries. The docking of some of the great foreign steamship lines on the New Jersey side of the North River has been referred to as if it were in some way to the discredit of New York. No good result can come from such a narrow treatment of the problem. The port of New York is not Manhattan Island. It is a mistake to land on its crowded water-front bulky goods which ought to be transferred direct to railway trains and which could effect such a transfer far more cheaply and expeditiously on the New Jersey side of the river. While the proposition to crowd the railways of the water-front of Manhattan Island is being discussed, it is well to bear in mind that within two or three miles of this crowded water front there is a strip of now valueless, shallow water on the New Jersey side, four miles long and about 1½ miles wide, that is in direct communication with all the great trunk railways of the United States and would accommodate all the foreign commerce of New York. It would be less convenient for passenger traffic than docks directly in New York; but for the transfer of goods intended for New York consumption, lighters would prove the advantage again of landing these goods at the nearest point of distribution, and drayage would be decreased. And for the passengers, a fast boat or rail service would do away with much of the inconvenience of distance from New York. The wider water front and decreased distance to the sea would certainly be advantageous to the steamship lines.

Of course, a large outlay would be necessary to build deep-water terminals for steamships on this site; and it would have to be done by private enterprise, since neither New York City or State could undertake to develop port facilities on New Jersey soil, and the New Jersey municipalities are hardly able financially to undertake the work. That private enterprise will eventually undertake

this development, however, there can be little doubt.

Broadly summed up, the area of lower Manhattan Island is too much in demand and too high-priced to permit the cheapest work in freight transfer to be done upon it. Just as heavy manufacturing industries have been driven off Manhattan Island, by the high cost of land, so the facilities for the shipment of grain, coal, ore and similar bulky commodities must be carried on at a disadvantage on Manhattan Island. There is plenty of cheap land and available water front in and about New York harbor which can be as well used for this, and such sites must be chosen if New York is to hold its own in competition with rival ports.

LETTERS TO THE EDITOR.

Increase of Bridge Strains with Velocity of Trains.

Sir: It may be well to point out to Mr. Dufour (Eng. News, Feb. 24) that his formula simply means that the increase of stress as shown by the second term within the brackets is that due to the centrifugal force of the train traveling on a curve due to the deflection of the load, and that this is all there is theoretically in the subject, unless the load be very great in comparison to the weight of the girder.

Practically there is some question whether the time necessary for strains to travel throughout the various members of a structure and thus be distributed according to theory may not cause higher strains in some members.

As the increased strain due to the centrifugal force as given in Mr. Dufour's formula assumes a downward deflection, we see that with camber the directly opposite result will be obtained when the comparison is made with a horizontal track.

It is perhaps partially due to this fact that actual tests made on girders and bridges give such contradictory results in different cases. Yours truly,

Theodore Cooper.

35 Broadway, New York, March 3, 1898.

Sir: In one of his cautionary remarks to the young engineer, Mr. J. C. Trautwine, Sr., said: "Theory, uncontrolled by observation and common sense, will lead to great errors in every department of engineering." This remark seems to apply well in the case of the recent correspondence on the increase of bridge strains with velocity of trains. The theory that a certain formula applicable to a simple beam of uniform section deflecting below a level line when the live load is passing over the beam, should surely not control the fact that a bridge spoken of by "Measure," in the Brooklyn "Eagle," is a structure to which the formula cannot be applied without modification.

The deflection and therefore the stress due to shear in actual bridges is not accounted for in the formula quoted in your issue of Feb. 24. Camber, by which the change in length of span due to deflection is avoided in framed structures; the construction of the roadwny in all bridges, or the rolling stock resulting in synchronous impacts; and the profile of the roadway are not and cannot be provided for in a general formula other than in the stereotyped "other things being equal," which covers a multitude of impossibilities. The failure of the formula in the case of high velocities is the indication of its failure at other velocities; likewise the representation that the whole of the dynamic effect of the velocity is applied vertically to the bridge, whatever the increase in velocity, is contradicted by the well-known creeping of rails. It therefore follows that, notwithstanding the recent revelations that the strain "varies with" the square of the velocity, it is a truth that the strain does not vary as the square of the velocity. Yours truly,

Jno. I. Riegel.

South Bethlehem, Pa., March 5, 1898.

The Port Arthur Terminus and Ship Canal of the Kansas City, Pittsburg & Gulf R. R.

Sir: In your issue of the 17th inst., there is a long and interesting account of the Kansas City, Pittsburg & Gulf R. R.—a railway of much importance to this port, as well as to the grain country tributary to Kansas City. Mr. Stilwell and his associates have shown remarkable energy and ability by the construction of the road in such unfavorable times, and deserve great credit for the results obtained and I have no desire to in any wise detract from it.

The article in question, however, in the section on p. 119, devoted to "The Gulf Terminal at Port Arthur" is grossly inaccurate and does a serious injustice to the port and town of Sabine Pass. The town, of Sabine Pass suffered from an overflow from the Gulf in 1886, as most places on the Gulf shore have suffered at one time or another, but the account given is very much exaggerated. The flood came in the night, and owing to the flimsy character of the buildings, and their being set on low wooden blocks, many of them were destroyed and considerable loss of life caused. The more substantial structures suffered comparatively little damage and are still in use. The ground at Sabine Pass is at least as high as at Port Arthur—is about the same level as Galveston originally was—and is higher than the ground at Taylor's Bayou where the Port Arthur terminals are to be located.

The water did not rise 8 ft. over the town, but only above the lower portions of the water front, and there is every indication that it was equally high and had equal force at the site of Port Arthur, which was not then inhabited. The wind in this, the "great" storm of the region, was from the Gulf.

The statement that the storm of September, 1897, forced the waters of the lake over the lands at Sabine Pass (there is no "Sabine City") to a depth of 6 ft., is absolutely untrue. The water rose two or three feet over the ground along the water front and carried some logs and timbers ashore, but did not rise over the streets of either the old or the new town of Sabine Pass. The same raise of water occurred at Port Arthur, but no damage was done by water in either place, so far as the writer, who was here at the time, is informed. On the west side of the lake, however, where the proposed canal is located, the water rose much higher, and washed out the Southern Pacific track. The storm was from the north and northeast, and for about an hour in the evening it was very violent, and during that time blew down many frail structures.

The damage was much greater in Port Arthur than here, five persons being killed there by falling buildings and none here, and the damage to buildings was also much greater; but in both places the damage was principally confined to wretchedly built structures which would not weather an ordinary winter on the New Jersey or Massachusetts coast. The substantially built structures were practically uninjured.

Port Arthur is as likely to be inundated from the lake and rivers as Sabine Pass is from the Gulf, and in case of great rises of water from either Gulf or lake would be equally flooded.

The statement made that the proposed canal will probably be completed this year and will be opened through, 16 ft. deep, by June 1 seem absurd to any one acquainted with the true conditions. Work has been going on nearly a year with a result of only about 2½ miles of excavation from 8 to 21 ft. in depth, averaging probably 14 or 15 ft. at most.

At this time the Port Arthur Channel & Dock Co. is enjoined from entering on about 2½ miles of its route, its right to construct such a canal under its charter being contested, and its work at the lower end of the route has been recently stopped by the United States Engineers. It is now seeking permission of the Secretary of War to connect with the navigable waters of Sabine Pass and Taylor's Bayou. The latter stream it is proposed to cross with the canal.

It is a notable fact that the Kansas City, Pittsburg & Gulf R. R. has no entrance of its own into Kansas City, and is now arranging to pay tribute at its Gulf terminal to a channel and dock company, although ample grounds here on deep water have been freely offered it.

It will be interesting to note in the future whether the profits on its townsite scheme at Port Arthur compensate the railway company for the increased cost on all its export business which its costly and unnecessary ship canal will entail. Yours truly,

Jos. O. Osgood,
M. Am. Soc. C. E.

Sabine Pass, Tex., Feb. 22, 1898.

(We submitted a proof of the above letter to Mr. Robert Gillham, General Manager and Chief Engineer of the Kansas City, Pittsburg & Gulf R. R., and append his reply as follows:—Ed.)

Sir: In reply to Mr. Osgood's statement in his letter, of which you have sent me a copy, the statement published in Engineering News with reference to the tidal wave of 1886, is unquestionably true, in support of which I quote from the Report of the Chief of Engineers of the United States (p. 1386, in Government Engineer's Report to the Secretary of War, dated October, 1887):

In this same month (October, 1886) during a violent gale on the Gulf, a tidal wave arose and inundated temporarily the entire country bordering Sabine Pass and Lake. The water is credibly reported to have reached a height of 8 ft. above the ground on which the town of Sabine Pass stood. In less than an hour from the time this wave reached its height, over 90% of the houses in Sabine Pass were either lifted off their foundations, thrown down, drifted away or destroyed. One hundred and thirty lives were lost, and the few people spared were left destitute. The current is reported to have run with a surface velocity of over 20 miles per hour, and its direction inward from the Gulf toward the lake. At all events, in a very short time, with the exception of 5 or 6 houses, Sabine Pass as a town was wiped out of existence. An examination of the jetties made a few weeks after the storm, showed that the injury to jetties due to the storm was slight.

With reference to the overflow in September, 1897, contiguous to Sabine Pass, Mr. Osgood admits that several miles of the Sabine and East Texas Railway tracks, known as a branch of the Southern Pacific, were washed away, which could not have occurred had the water been much less than 6 ft. in depth. The only means of reaching Sabine Pass during the rebuilding of the railway was by means of boats running from Port Arthur to Sabine Pass. The Canal Company will keep all its promises with reference to the completion of the ship canal. Contracts have been made for the placing of three additional hydraulic dredges on the canal, all of which will be at work very soon. Mr. Osgood can make his own calculation to determine the time required to secure 16 ft. of water throughout the entire canal.

The United States Court have dissolved all injunctions and authorized the continuance of work where, by injunctions, the United States Court required a temporary suspension of work.

The article published in the Engineering News was most complete and in all respects substantially true and no exceptions should have been taken to this article. It is a fact that Mr. Osgood is the manager of a land company owning land at Sabine Pass, where to some extent efforts are being made to develop a town. The interests having control of the land at this point have shown unusual interest in the welfare of Port Arthur and the ship canal, and have always pretended to believe that the ship canal was an impracticable enterprise and that the railway will never be a success unless the plans are changed and Sabine Pass made its terminus.

We thank them for their interest, but have no desire to follow their suggestions. Very respectfully,

Robert Gillham,
M. Am. Soc. C. E., M. Inst. C. E.

Kansas City, Mo., March 3, 1898.

An Inquiry Concerning Mechanical Root Extractors.

Sir: By your courtesy I solicit expressions of opinion from engineers and engineering societies, respecting the selling price, the power, and the degree of approximation which would be most agreeable to them, in mechanical root extractors, which I have designed and shall have made, for solving problems involving equations of the third and higher degrees.

The first of these extractors made, a 10-in., third degree extractor, laid off by hand on cardboard, without the use of instruments of precision or graduating machines, gives third degree roots within 1%. Probably engineers' work will be most facilitated by making two forms of this machine; one for the third degree and another for some higher degree, say the twelfth power. The third degree extractor will solve third degree equations only. The twelfth degree extractor will solve equations of any degree up to the twelfth. This may not be of great enough power, and it may be that a less costly extractor, of lower power, will give the roots of practically all the equations which an engineer need form in solving his problems. Cheap extractors, of moderate size, printed on cardboard, will give roots within 1%. Extractors of large size, made of metal, with the graduating done in the most perfect possible manner, will give four or five figures of the root.

The governing principle of the extractor is very simple, and facility in using it can be acquired as readily as in the case of the slide rule. It is not probable that a sufficient number can be sold to justify manufacturing more than two or three powers, and I will, therefore, be grateful to engineers and engineering societies, and generally to those who use the higher mathematics in their daily work, if they will express their opinions as above requested, by letter, in order that the extractors manufactured may be of the powers most useful for practical work, and not too costly.

These extractors will not read the root of any equation; but any problem may be expressed in an equation within their power, so that several figures of the roots can be read off, as on the slide rule. Yours truly,

Chauncey N. Dutton.

11 Broadway, New York, N. Y., Feb. 21, 1898.

Concerning the Proposed Niagara River Bridge.

Sir: My attention has been called to a paragraph in your issue of March 3d, regarding the proposed Niagara Bridge, in which you quote from the Buffalo "Commercial" some remarks which charge the promoters of the project with being charter-mongers, and who are said to be the same men who secured at Albany the Queen City Gas Company's franchise and then sold it instead of making gas. The article in the "Commercial" was fully and squarely answered with a flat denial. It is utterly untrue that any of these men referred to are connected with the enterprise. One of them was at one time interested, but not now, and I was one of the two men who spoke before Governor Flower in the strongest terms against the granting of the gas franchise. As a matter of fact, the state has already granted the franchise for the bridge and all that is wanted now is permission from Congress to cross a navigable stream, and the request is backed up by the approval of the government engineers. The men forming the company are abundantly able to build the bridge when the consent of Congress has been obtained. That such a bridge is a necessity to the people living on Grand Island, and that it would be of great benefit to the people of Buffalo, is undoubted.

It would not be difficult to answer the innuendoes of the

"Commercial" from the standpoint from which its remarks are made, but I prefer to avoid all personalities. "Honi soit qui mal y pense." It is unfortunate that no one can engage in the furtherance of any great improvement of this kind without having his motives impugned and misrepresented. If the "Commercial" can find anyone, whose only interest is the public interest, to take my place in the Bridge Company, I am ready to give place to him.

Yours respectfully,

J. M. Adam.

Buffalo, N. Y., March 5, 1898.

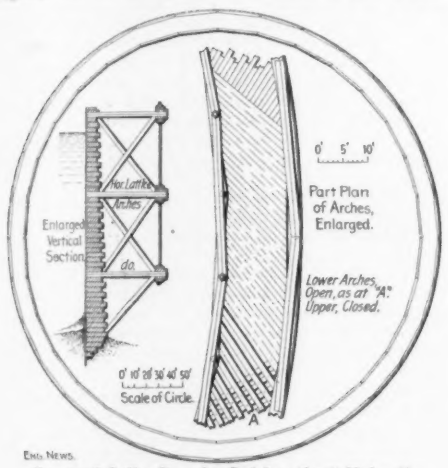
Building a Coffer-Dam Around the "Maine."

Sir: Being an old shipbuilder, acquainted with wrecking and with the material available on the Gulf coast, I take the liberty of offering some ideas on the subject of raising the battleship "Maine."

It appears that the ship lies in some 40 ft. of water, in mud which will protect it from destructive strains when the water is removed.

The mud bottom offers a good seat for a coffer-dam, and I believe the ship can be raised and brought home as cheaply as it can be blown to pieces and removed piecemeal.

The accompanying diagram represents a coffer-dam, 360 ft. in diameter, for 40 ft. of water and mud bottom. The sides are 50 ins. thick at bottom, 20 ins. at top, besides the crown or arc of the arch sections; these may be, as they take three or more pieces each, assembled, bolted together and cut to template at the mill; so that in put-



Eng. News.

Proposed Coffer-Dam for Raising the "Maine."

ing up, the principal work is handling, treenailing and planking the outside. No vertical iron fastening is used except for the inner edges of the horizontal lattice arches, which are fastened with screw bolts, which will facilitate taking down without destroying materal.

In building such a structure, much time would be used and some uncertainty remain in attempting to get perfect butt joints between the arch sections forming the outside. To avoid this, leave these sections from ½-in. to 1 in. apart, and tamp the joints with Portland cement. This being wholly boxed in, and subjected to a pressure of less than 1,000 lbs. per sq. in., makes the bearing of the sections on each other uniform, and permits rapid assembling.

The horizontal arches, which can be made of any strength desired, preserve the strength of the shell by resisting deformation, by collapse or shock, and give convenient platforms for loading and work. The estimates are for the work assembled and built in place, with no allowance for hindrance or accident. The work would require about 120 tons of iron (posts, bolts, spikes, etc.) and 3,700,000 ft. B. M. of timber. This would cost on the Gulf coast from $82,000 to $85,000. To remove, unload and, if necessary, lift to clear from mud, cut outside planking, wedge up and saw the treenails, which are the only vertical fastening remaining, the screw bolts at the inner edge of the horizontal arches allowing their separation. The whole may be taken apart without loss of material except the outside planking.

G. W. Pearsons.

1611 Baltimore Ave., Kansas City, Mo., March 1, 1898.

(It appears to us that the character of the mud at the bottom of the harbor would have much to do in determining the success of the plan. A porous silt would be apt to admit so much water underneath the sheet piling as to make it impossible to pump out the enclosure.—Ed.)

THE ESTABLISHMENT AND CONSERVATION OF THE PURITY OF PUBLIC WATER SUPPLIES.

An address on the above subject was delivered by Mr. W. T. Sedgwick, Professor of Biology at the Massachusetts Institute of Technology, before the New York Pathological Society on Feb. 28. The address was opened by stating that with the growth of urban society private supervision of matters pertaining to health gives way to public supervision. Life is dependent on food, air and water. Of these the supervision of our water supplies is of the most significance, for food is mostly cooked, air cannot be controlled, but the quality of our water supplies may be.

Most of the points made in the address are familiar to well-informed engineers, but some new ideas were advanced or old ones expressed in suggestive ways, as noted below.

A large part of the water flowing in many of our streams is fed to them from the ground after having been highly purified by a long process of natural filtration in which the bacteria of the soil play an important part. The polluted water coming to the streams directly from the surface of the ground is much diluted in this way. On steep drainage areas this natural filtration has less opportunity to exert its beneficial influence, and hence water from such sources is liable to be badly polluted.

The strange fact that a few years ago engineers and sanitarians not only tolerated, but even recommended sewage-polluted streams as sources of water supply is to be explained by their belief in the so-called self-purification of rivers. Chemically, a purification does appear to be effected after a flow of a few miles, but this is largely due to dilution by pure ground water. Some pathogenic bacteria disappear as the water flows along, due largely to unfavorable environment. But on the whole there is not so great a bacterial improvement as is to be desired. Still water really gives a better opportunity for bacterial purification than does flowing water. No river water, used directly, is safe, unless it comes from a sparsely-settled drainage area. Philadelphia is anachronistic in using such a supply as it does.

The value of quiescence, or sedimentation, in lakes, ponds or reservoirs, was discussed at some length. The water supply of Burlington, Vt., was cited as a notable instance of the benefit of quiescence. Burlington is the only city in New England taking its water supply from and discharging its sewage into the same body of water, but there are plenty of cities elsewhere that do so. For many years the sewer outlet and water intake at Burlington were within one-half mile of each other. Although there were many cases of diarrhœa there, especially among strangers, the number of cases of typhoid fever was not so very large. In 1885 the sewer outlet was moved one-half mile further away from the water intake. In 1892 Prof. Sedgwick found, on examining many samples of water from the lake, that at a point only 100 ft. away from the sewer outlet 90% of the number of sewage bacteria had disappeared; at 1,000 ft., scarcely any were to be found; and a mile away none could be discovered. For three years the water from the intake was examined and no evidence of sewage found. Here was a case where dilution did much and quiescence more. The sewage discharged into a natural basin and was small in amount. There were no regular currents in this part of the bay, but some wind currents. Burlington has since extended its intake to a point three miles out in the lake.

In such cases as the above some of the bacteria are killed by cold water; some sink to the bottom; others are devoured by predatory infusoria; some hardy ones remain, but multiply little or none and are probably harmless.

Besides the benefits from storage the quality of water when stored may be conserved by stripping reservoir sites of organic matter, thus lessening or preventing the growth of organisms giving rise to offensive tastes and odors. Of the $9,000,000 now being expended by Boston and 28 other municipalities for the Metropolitan water supply about one-third will be used to strip the site. In this supply purity is secured in four ways: (1) By selecting the purest natural source that could be found; (2) by stripping the reservoir site; (3) by preventing pollution; (4) by quiescence in the huge storage reservoir.

The ideal water supply would be drawn from an uninhabited drainage area. Where this is impossible a thorough sanitary patrol should be maintained. This is good work for young sanitary engineers.

The development of ideas regarding the protection of water supplies in Massachusetts was briefly sketched by the speaker. About 1870 the legislature passed an act prohibiting stream pollution within 20 miles above any source of water supply. After several intermediate acts, in 1897, the same body gave to the Massachusetts State Board of Health sanitary jurisdiction over all the drainage areas of the state (Chap. 510, Acts of 1897). Under this act, on complaint of any official of a city, or of a water or ice company, that a water supply is being polluted, the State Board of Health has power to give a hearing and to prohibit the pollution under penalty of fine or imprisonment, or both.

A great source of danger to water supplies is their pollution by workingmen during construction of wells of reservoirs. Several instances of this sort, followed by typhoid epidemics, were cited. One of these, connected with the water supply of Cambridge, Mass., where Professor Sedgwick was called in to act as an expert, was noted in our issue of Jan. 6, 1898. Picnic grounds and summer resorts are other sources of pollution requiring much care of late. Sewage from such sources, as well as from villages in drainage areas, must either be diverted or purified.

At the close of the address the speaker said that but few American cities take proper scientific care of their water supplies. All surface waters should be stored. Lowell said: "Old wine to drink, old books to read, old wood to burn." He might have added, old water to drink. Where storage is not sufficient, filtration should be employed. Storage, both before and after filtration, is desirable. The watchword must ever be, "Continued expert scientific supervision." Until then "public water supplies will be public dangers."

DEVELOPMENT OF THE IRON ORE INDUSTRY IN THE LAKE REGION.

In the late report on lake traffic, made by Special Agent George G. Tunnell to the Treasury Department, there is much of interest relating to the production of iron ore in this section. Within about 15 years the Lake Superior iron ore region has developed from a comparatively small producer to contributing almost twice as much ore as all the rest of the United States combined. In 1880 the total iron ore production of the United States was 7,120,362 long tons, and to this amount the lake region contributed 1,677,814 tons, or 23.6% of the total. In 1896, 16,005,449 long tons were mined in the United States, and 10,566,359 tons of this, or 66%, came from the lake region. The explanation of this is that these latter ores are much richer in iron than that from other sections, and the general ease with which it is mined and transported by water to the East has encouraged a large output and reduced the price.

In the same period, 1880-1896, the iron mines of New York, Pennsylvania, New Jersey and Ohio decreased in output from 4,243,372 long tons in 1880, to 1,456,740 tons in 1896; the decline being especially rapid after 1889. In percentage of the total product of the United States, the fall in production for these states was from 59.59% to 9.10% between 1880 and 1896.

But during this same period the output from the Southern mines increased rapidly, though much slower than the mines in the lake region. The Southern mines are isolated, their ore does not come into direct competition with the lake ores, and transportation charges constitute a barrier. These Southern ores are non-Bessemer in quality, and are either too high in phosphorus or this ingredient is very unequally distributed; though this remark does not apply to the Cranberry ore of western North Carolina, and other ore of the better class is supposed to exist in the region just about Cranberry.

Most of the lake ore is low in phosphorus, and it is largely of Bessemer quality; the exception being the mines of the Menominee range. Unlike the Southern ores the lake ores are very free from sulphur—and titanic acid is usually absent. In comparing the yearly shipments of ore from the lake region between 1881 and 1896, inclusive, the

five-year periods would show the following growth:

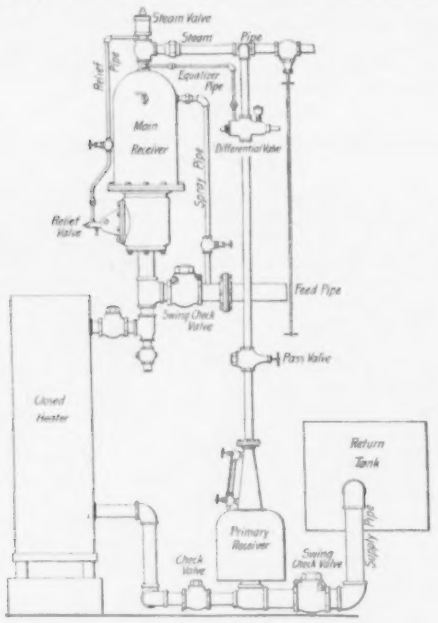
Year.	Michigan, tons.	Minnesota, tons.	Total for—— Lake Superior region, tons.	United States, tons.
1881	2,123,404	.....	2,321,315	7,974,000
1885	2,203,599	227,075	2,485,855	7,600,000
1890	7,141,656	891,910	8,944,031	16,036,043
1896	5,706,736	4,283,880	10,566,359	16,005,449

As reduction in freight rates is also a key to the growth in business, the following table is condensed from one giving the average yearly freight charges per long ton of ore by lake vessels plying between Marquette and Lake Erie ports:

Year.	General rate.	Wild, or daily.	Contract.
1856	$3.00	.....	.....
1860	$2.00 to $2.50	.....	.....
1865	2.05 " 5.00	.....	.....
1870	2.05 " 3.25	.....	.....
1875	1.30 " 1.50	.....	.....
1876	1.25 " 2.50	$1.35	$1.50
1880	2.00 " 2.75	2.26	2.75
1885	1.40	.98	1.05
1890	1.25 to 1.10	1.07	1.25
1895	....	.92	.75
1896	....	.66	.95

THE SCOTT GRAVITY BOILER-FEED APPARATUS

We illustrate herewith an appliance which has recently been put on the market by the Q. & C. Co., of Chicago, for feeding water to a boiler without the use of a steam pump or injector. The principle of the apparatus consists in first elevating the water into a closed tank or receiver placed above the level of the boiler, and then allowing it to run by gravity into the boiler. The cut shows the apparatus as arranged to take cold or warm water from a return tank or other source of supply, passing it through a closed heater into



The Scott Gravity Boiler Feed Apparatus.

the elevated receiver and thence into the boiler. The method of operation is described in detail as follows:

Water from the return tank enters and fills the primary receiver by gravitation, and is then driven to the main receiver by steam pressure admitted to the primary receiver through the differential and pass valves. When the main receiver is thus filled, the steam valve at the top rises and admits steam to the surface of the water. The pressure above the water balances the pressure from the boiler upon the check valve in the feed pipe, and the height of the column of water causes it to fall by gravity, discharging into the boiler. A closed heater may be placed in the circuit between the primary and the main receiver, as shown in the cut.

During the time when the main receiver is discharging into the boiler, the primary receiver is re-filling, the steam to force the water from this primary receiver being alternately admitted or cut off by the actions of the differential valve.

The motions of this valve are governed by variations of the pressure in the main receiver, communicated by the equalizer pipe, in such a way that while the main receiver contains full boiler pressure, the valve is closed, but when pressure in the main receiver is reduced by a few pounds the valve is opened. When the primary receiver has refilled, it awaits the reduction of pressure in the main receiver, which is needed to open the differential valve.

Assuming the primary receiver to be filled with water and the main receiver to be discharging, the latter will contain full boiler pressure and the differential valve will be closed. The main receiver will continue to discharge until the water recedes to such a level as to allow the float of the relief valve device to fall. This closes the steam valve above and confines a volume of steam equal to the capacity of the receiver above the water level. Natural radiation, with its consequent condensation, then almost instantly causes a slight reduction of pressure in this receiver below the pressure in the boiler, and this small reduction permits water to be driven back to the main receiver through the spray pipe, which is connected to the boiler feed pipe.

The spray which this returning water forms by impact against a deflecting plate, falls through the steam and instantly causes a much greater reduction of pressure, amounting generally to 30 or 40 lbs. This fall of pressure opens the differential valve and admits live steam to the surface of the water in the primary receiver, and now full pressure in the latter drives the water to the main receiver. As the main receiver fills, its pressure rapidly recovers until it equals that of the boiler. The differential valve then closes, thus allowing the steam in the primary receiver to exhaust and enabling the receiver to refill with water, which condenses whatever steam remains. A repetition of these actions makes the operation of the device continuous. The rapidity of the operation varies with the boiler requirements. Though usually arranged to make from two to three discharges per minute, a sudden call upon the boiler will cause the appliance to accelerate its speed of action, while a lesser requirement will correspondingly retard it.

SANDLESS PIG IRON—ITS ADVANTAGES TO THE PRODUCER AND CONSUMER.*

By Edward A. Uehling, M. Am. Soc. M. E.

"Necessity is the mother of invention," and the casting machine which dispenses with the old-fashioned pig bed of the blast furnace came into existence through sheer necessity, not to say desperation. Carrying the iron from the pig beds has always been considered the hardest task about a blast furnace. So long, however, as the output did not exceed 100 tons a day, there was comparatively little trouble. But where is the furnace to-day, the daily output of which does not exceed 100 tons? The general average daily output approaches more nearly 300 tons, 400 tons is nothing unusual, 500 tons per furnace has been exceeded by the most modern furnace plant, and 600 tons daily average will undoubtedly be reached by many of the furnaces in the near future.

No wonder that furnace men have been racking their brains in the endeavor to contrive some mechanical means that would take care of the pig iron. Imagine yourself a poor furnace manager, who, forced by the small margin of profit, to get out a maximum product, has been chasing about all day and probably half the night to make sure of his stock supply, to keep up his heat, his steam, his engine revolutions, to get in the necessary cinder and iron cars, so as to be certain that there would be no avoidable cause for interruption. Just imagine yourself being rung up at 3 o'clock in the morning to come to the furnace at once; and when you get there you find the furnace full of molten iron, both sides of the cast house full of pig iron, and the iron carriers also "full."

Something must be done and done quickly, for the furnace in that condition is liable to break out at any moment. To send for the day shift would be useless, for they were probably full too. At any rate, it would be questionable whether many, if any, of them would respond. They know it is very difficult to replace them. They can afford to be independent and you must be thankful if they are on deck to take care of the iron on their own shift. You call out the laboring gang. Every available man is put at iron carrying—and what a fist the majority of them make at it. It would be funny if it were not so serious. Meanwhile the iron is getting above the line of safety. It is liable to break out any minute. The flush of cinder has just run iron over and cut the monkey. You know from this that the iron will soon be getting dangerously close to the tuyeres.

Finally one side of the cast house is cleared. The beds are being molded up as quickly as possible, while the iron is being hurried out of the other side. The furnace has already been held in two hours over time. You know that one side will not begin to hold all the iron. It is therefore necessary to prepare for a cross over. The cinder is now up to the tuyeres, the iron cannot be far away. You do not want to run another flush of cinder for fear of losing a lot of iron, and cutting the cinder cooler also, the monkey having already been lost. You cannot take the wind off, because every tuyere would immediately fill with cinder, and possibly with iron. The situation is getting more dangerous every minute. To facilitate matters you set the skimmer yourself, while the keeper is slicking up the runner, and the helpers are molding up more pig beds. At last everything is ready and the furnace is being tapped. You draw a temporary sigh of relief, for had the furnace broken out before the pig had been removed from the beds, the result can be easily imagined.

Although safely over the worst, you are not certain what will happen until the iron is all landed in the pig beds, and you are just beginning to tap. She comes easy, a few blows of the sledge hammer suffice to drive the tapping bar into the molten contents of the furnace. The bar is quickly withdrawn and the liquid iron follows. The extraordinary head of iron in the hearth soon runs the hole to double its proper size, the iron gushes forth and fills the runner to overflowing, and reaches the lower end of the cast house in a torrent. Two, three, four, five, six beds have to be opened up simultaneously to manage the iron. Some of them overflow, sheeting the whole bed before the others are half filled. In the hurry to get the beds down, the scrap had not been carefully sifted out, and the cores were insufficiently tramped, consequently there is "jumper" after "jumper." The molten metal coming in contact with a piece of wet scrap immediately causes a boil. The liquid iron flying in every direction makes it impossible to open the beds adjacent, consequently you have to cross over before half the iron is out of the furnace. What this means must be experienced to be fully understood. Towards the end the flow of the iron becomes more controllable, but the rush of cinder is all the greater. The skimmer is washed away and what had been saved from the boil, and had not been spoiled by jump cores, is deluged by a mass of cinder. Your eyes are red from the fumes, your face is blistered, your clothes are on fire, and over half the iron is in a worthless mess. You do not swear. There are no words to express your feelings. The combined vocabulary of all the languages in the universe could not furnish appropriate words sufficient to do justice to the occasion. And all this on account of inadequate means for handling the iron produced and because the iron carriers got full.

Yet, looking at it from a disinterested standpoint, who can condemn the iron carriers for getting full. The work is such that you can hardly blame them for taking a day off—and it was pay day—the temptation was great.

The task of carrying pig iron is not fit to be performed by human beings. The extraordinary muscular exertion which is required bars four-fifths of the laboring class from standing up under the strain at all, and the necessity of passing back and forth, between the heat and the steam in the cast house and the chilly air outside, is enough to kill a horse. It is furthermore a fact that similar messes, more or less serious, occur when the iron carriers are at their post. Every furnace man is ready to admit that the old way of handling the iron at the blast furnace is entirely inadequate and cannot be continued.

From this apparent digression from my subject it is evident that there was ample incentive to blast furnace managers to invent a casting machine. There are probably few furnace managers who have not in their hours of trial, or shortly after, invented one or more ways of displacing the iron carriers. Most of these ideas, born of desperation, never took tangible form. A large number of contrivances, no doubt, got onto paper, and were either abandoned as impracticable or the originators lacked the courage or the means to give their inventions a practical test. Not a few have been built and found their way into the scrap heap. There now exists, however, a successful casting machine, which does all that can be desired, and its advantages to the producer of pig iron are such that no blast furnace can afford to be without it.*

In proof of this it will suffice to say that the casting machine at the "Lucy" furnaces, which has been in operation since the 3d of April, 1897, had up to the first of January handled 163,497 tons of iron, 18,000 of which was speigel. During all that time it did not miss a single ton of the output of the two furnaces. It was, and is, always ready to take the iron when it is brought to it. The machine at the Duquesne furnaces has demonstrated its capacity to take care of 1,200 tons of iron in 24 hours with ease.

The cost of handling the iron at the "Lucy" furnaces, including all repairs to the machine, ladles and refractory material was 10.6 cts. less per ton than that of handling it the old way, thus effecting a saving in labor cost of $17,330 in nine months, or $21,663 in a year. The scrap made is less than 25% of that made by the old way. Contingencies like those faintly pictured above cannot occur. The ladles are returned to the furnace as soon as emptied and the furnace can be tapped whenever desired. There are no boils, no "jump cores," no sheeted beds, there is neither scruff nor cinder on the iron. The pigs are uniform, smooth and clean.

The labor required about the machine is so easy that it looks like child's play compared with the other work about the blast furnace. Not a pig of iron is touched by hand from the time it leaves the furnace until it reaches its destination, or is piled on the stock-yard.

*Condensed from a paper read at the meeting of the Foundrymen's Association, Pittsburg, Pa., Feb. 26.

*An illustrated description of the Uehling casting machine and pig iron conveyor appeared in our issue of April 29, 1897. Mr. Uehling writes us that on Feb. 25 the machine at the Duquesne furnaces handled all the iron of three of the furnaces, which was at the rate of over 1,500 tons in 24 hours. Machines are nearing completion for the Carrie and the Struthers furnaces, and the Monongahela furnaces have taken a license. Two machines are now under construction abroad, one at the Millom and Askam Hematite Co.'s, in England, and the other at the Roechling Stahl Eisenwerke, in Germany.—Ed. Eng. News.

These are, in brief, a few of the advantages that will accrue to the producers of sandless (machine made) pig iron in which the consumer does not share. The advantages of sandless iron over sand pig, in which producer and consumer share alike, may be summed up as follows:

1. The abomination called the "sand ton" will be done away with. A ton of pig iron will be 2,240 lbs., and if it weighs that at the furnace, it will weigh the same at the foundry. And with it nine-tenths of the wrangling over short weights will disappear.

2. Grading by fracture will no longer be the basis of quality and price, and this will remove the most prolific bone of contention between producer and consumer of pig iron. The fracture of pig iron is a delusion and a snare. There is not one man in ten, whether consumer or producer, that can tell by the fracture a pig of iron suited for car wheels from one fit for stove plates.

Nearly every pig of iron varies in grade from one end to the other. Not infrequently you can show up three distinct grades in one and the same pig. The sow, if at all heavy, is invariably from half to a whole grade higher than its pigs. Is the iron in the sow therefore of a better quality? This is hardly reasonable, yet you pay from 50 to 75 cts. more for it. The value of an iron does not depend upon its fracture, nor is the fracture any guide as to the special purpose for which a certain iron may be best suited.

Chemical composition is the only true guide by which iron can be intelligently judged as to its quality and fitness for the purpose in hand. The greatest drawback to the practical application of chemistry in the foundry is due to the fact that with iron cast in the sand in the ordinary way it is almost impossible to get shipments of uniform composition. The iron as it flows from the furnace is very irregular, and it not infrequently happens that there is a difference of 1½% in the silicon from the first to the last bed in a cast of iron of practically the same grade.

The last, but not the least, mutual benefit that will be derived from the use of the machine for casting sandless foundry iron will be due to the fact that it will not only be possible but very easy to furnish iron of uniform composition. The iron of each ladle containing 15 to 20 tons will of necessity be uniform, and can be easily analyzed and piled or shipped according to analysis.

We now come to the advantages that sandless pig iron will have for the consumer alone. In the first place, I am authorized to say that in the basic open hearth furnaces at Homestead, where all the iron produced by the "Lucy" furnaces has been consumed, sandless pig iron has been demonstrated to be worth at least 50 cts. a ton more than sand iron of the same composition. This enhanced value is due first to the fact that it melts more readily than iron with a crust of sand about it, and is in a more advanced state of reduction when melted, hence it is more quickly converted.

Second. The sand damages the hearth, and requires additional flux. The sandless pig is harmless and the flux required is a minimum. Thus saving material, as well as wear and tear.

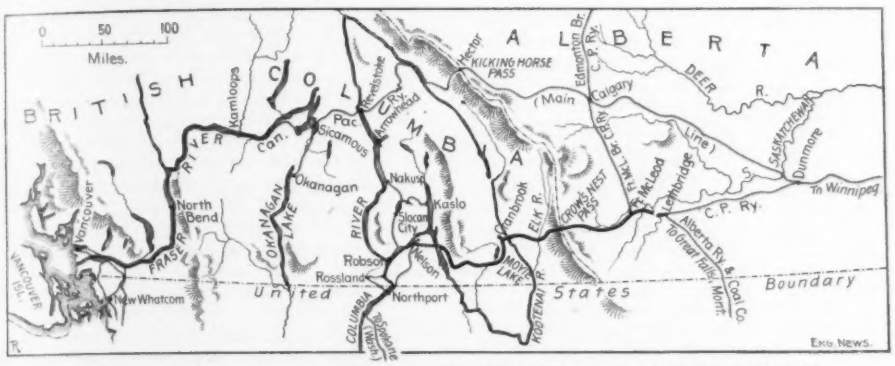
Third. In consequence, less fuel is required to convert the sandless pig into steel, which, fourth, results in an increased output.

The same holds true in remelting in the cupola for Bessemer steel. The sandless pig requires less flux, less fuel, melts more quickly, and results in appreciably less wear and tear in the cupola. No systematic tests have as yet been carried out, but the advantage of the sandless pig iron is easily estimated at 10 cts. per ton.

The results obtained by Mr. Thos. D. West indicate clearly that there is less oxidation from clean iron than from iron cast in the sand, otherwise of identical composition. The average of Mr. West's experiments showed the loss by oxidation in remelting sand iron to be 5.5%, while the loss in sandless iron was only 3.4%. Taking pig iron at $10 a ton, the loss on the sand iron would be 55 cts., against 34 cts. on sandless pig—a clear gain in favor of the machine iron of 21 cts. per ton. These results will require corroboration on a larger scale before they can be taken as absolute, but they indicate what may be expected.

THE CROW'S NEST PASS EXTENSION OF THE CANADIAN PACIFIC RY.

One of the most interesting railways now under construction is the Crow's Nest Pass line of the Canadian Pacific Ry., which is being built to open up communication with the rich mineral regions of the Kootenai district in the southern part of British Columbia. The company has for some time owned several short isolated railways and connecting steamboat routes in this district, so that by leaving the main line at Revelstoke and taking the branch to Arrowhead and then down the Columbia River to Nakusp, access could be had by rail, boat, and trail to the principal parts of the district. The only direct railway connection, however, is with Spokane, Wash., which is reached by the Nelson & Fort Sheppard Ry., so that the bulk of the supplies shipped into and ore shipped out of the district has been carried to and from the United States. When the rich gold deposits were discovered in the Kootenai district a few years ago, the Canadian Pacific Ry. made investigations as to the practicability of getting a line in from the east, crossing the main range of the Rocky Mountains at the Crow's Nest Pass, which was at one time proposed for the main line,



SKETCH MAP OF THE CROW'S NEST PASS EXTENSION OF THE CANADIAN PACIFIC RY.

but was then abandoned for the Kicking Horse Pass route, further north. The investigations showed that a line could be built and that the traffic would warrant its construction, and upon a subsidy being granted by the Dominion Government the company started upon this extension. The general route of the line is shown in the accompanying sketch map, from which it will be seen that it commences at Lethbridge, the terminus of a branch from the C. P. Ry. main line, originally built by the Alberta Ry. & Coal Co. It then extends westward to the pass, then down the Elk River, across the east branch of the Kootenai River, and on to the head of Kootenai Lake, on the west side of which it will terminate at Nelson, 330 miles from Lethbridge, by a junction with an existing line which has connections with the famous mining centers of Rossland, Trail Creek and Slocan. An extension from Slocan City northward to Nakusp and Arrowhead would afford a connection with the main line again, but whether this will be built, or whether the line will be extended westward to the Okanagan district and the Fraser River remains to be seen.

It was decided to build the Crow's Nest Pass line by small contracts under the direct supervision of the railway company, and Mr. M. J. Haney was made Manager of Construction, the work, of course, being under the general direction of Mr. P. A. Peterson, M. Am. Soc. C. E., Chief Engineer. We are indebted to Mr. T. C. Shaughnessy, Vice-President of the Canadian Pacific Ry. Co., for a copy of a report from the engineer of the line, from which we take the following description.

The line is now located from the eastern terminus at Lethbridge to the crossing of the Kootenai River at the upper end of Kootenai Lake, a distance of, say, 287 miles, and preliminary surveys have been made to Nelson.

For the first 80 miles the line passes over what is called a prairie country, but very heavy grading is encountered as well as the heaviest bridge work on the line. This is owing to the necessity of crossing St. Mary's River, Belly River, Pincher Creek and the South Fork of the Old Man River, as well as the many coulees met with in order to reach these crossings. The following table is a list of the principal structures on the first 80 miles:

Miles.	Total Length. ft.	Maximum Height. ft.	Truss Spans.*
3½	405	110	....
7	420	105	....
7.1	390	98	....
7.8	450	85	....
8.0	660	65	....
8.3	400	130	1 × 130 D. H. T.
8.5	400	95	1 × 95 D. H. T.
8.8	400	90	....
9	500	75	....
9.6	200	80	1 × 150 D. H. T.
10	300	55	1 × 100 D. H. T.
10.3	400	35	....
10.6 St. Mary's R.	2,750	65	2 × 150 D. H. T.
12.2	660	120	1 × 150 D. H. T.
14.4	450	75	....
14.7	560	135	1 × 100 D. H. T.
15	300	50	....
16	630	130	1 × 100 D. H. T.
26.5 Belly River	495	30	....
58.3 Pincher Creek	710	110	1 × 150 D. H. T.
69	240	60	....
87.1	375	70	....
70 S. Fork Old Man River	935	135	2 × 150 D. H. T.
79.3 N. Fork Old Man River	190	20	1 × 150 T. H. T.

*D. H. T. stands for "Deck Howe Truss," and T. H. T. for "Through Howe Truss."

From mile 80 to 105.8 miles, where the line reaches the summit of the Rocky Mountains, the work is heavy, with a considerable amount of rock excavation. From the summit westward for 16 miles the work is heavy and involves the use of two tunnels and some six bridges from 60 to 200 ft. in length each.

The next 37 miles, following down the valley of the Elk River to the crossing of that stream, consist of earth and rock work with very heavy clearing and two bridges of 100 ft. span each. Elk River is crossed by three spans of 150 ft. each, and from there to the crossing of the East Kootenai River at Wardner, a distance of about 23½ miles, the earthwork is heavy, and there are three bridges of about 80 ft. span each. It is proposed to cross the Kootenai River near Wardner by three spans of 150 ft. each, one span of 130 ft. and a swing span with a clear opening of 60 ft. From Wardner to Cranbrooke, a distance of 23½ miles, the line passes through a park-like country, with the exception of about five miles, through what is known as Isidore's Canyon, where there is a considerable amount of rock excavation. From Cranbrooke to the head of Moyie Lake, a distance of 12.7 miles, the earthwork is moderately heavy. The line follows the east shore of Moyie Lake for a distance of about 8 miles and the work is heavy, being almost entirely rock, with one tunnel 500 ft. in length. After crossing the Moyie River, one mile below the lake, the line follows the west side of the valley for 21 miles, then turning to the westward and following up the valley of a small stream for three miles it reaches the summit between the Moyie and Goat River watersheds, in doing which the work is heavy. From the last mentioned summit to the head of Kootenai Lake, a distance of 35 miles, the work is heavy, with a considerable amount of rock excavation and trestle bridging.

The maximum grade used in either direction is 1%, or 52.8 ft. per mile, and the sharpest curvature is 12° (478 ft. radius), but curves as sharp as this have only been used in a few places and compensation for the same is allowed in the grade.

The grading was commenced July 14, 1897, and has been completed from Lethbridge to the summit. The bridging is well advanced, and track has been laid on 63 miles. The grading from the summit is now being proceeded with rapidly, and the entire work will very soon be covered by the contractors. Station buildings and water tanks are being erected at average distances of about 18 miles. These vary in design according to the requirements of the locality. The track is being laid with 60-lb. steel rails, though 72-lb. rails will be used on a large portion of the British Columbia section.

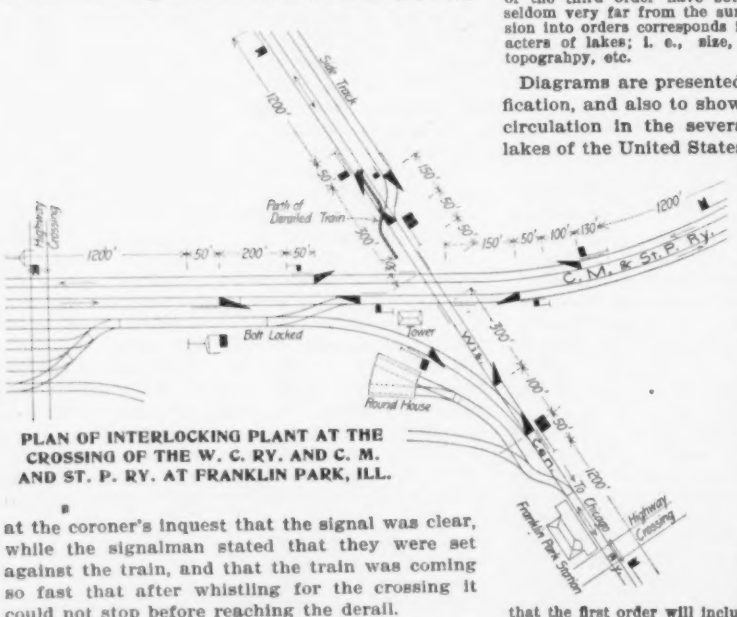
A very large proportion of the line from the summit of the Rocky Mountains westward passes through a densely wooded country, on a portion of which fire has destroyed a large amount of what would now have been valuable timber, but there are still considerable tracts of land on or in the vicinity of the line where excellent fir, spruce, larch and cedar can be procured. Valuable coal deposits are found close to the line in many places

for 35 miles on either side of the summit, and rich veins of galena and silver are being opened up in the vicinity of Moyie Lake.

In the province of Alberta the line passes through an excellent grazing country and ranching on both large and small scales has been successfully carried on for a number of years. There are also considerable tracts where land suitable for mixed farming can be met with, especially in the vicinity of Pincher Creek and in the valleys of the Old Man and Belly Rivers and their tributaries, and these could be greatly increased by irrigation. West of the summit, considerable tracts of land suitable for either grazing or farming are met with in the valleys of the Elk, Kootenai, Moyie and Goat rivers, and between the Elk and Moyie rivers the country passed through consists of bench lands with glades of timber and occasional sloughs, which make it especially suitable for stock raising.

A DERAILING SWITCH ACCIDENT AT FRANKLIN PARK, ILL.

On March 2 a fatal accident occurred at the crossing of the Wisconsin Central Ry. and the Chicago, Milwaukee & St. Paul Ry., at Franklin Park, Ill., about 15 miles from Chicago. The former line has a single track crossing the double track of the latter, and the accompanying cut shows a plan of the crossing, with the signals and interlocking. An extra freight train, southbound, on the Wisconsin Central Ry. was approaching at a good rate of speed when it was derailed by the derailing switch (A); the engine was upset and a brakeman who had been riding on the engine was killed. The engineman and fireman both stated



PLAN OF INTERLOCKING PLANT AT THE CROSSING OF THE W. C. RY. AND C. M. AND ST. P. RY. AT FRANKLIN PARK, ILL.

at the coroner's inquest that the signal was clear, while the signalman stated that they were set against the train, and that the train was coming so fast that after whistling for the crossing it could not stop before reaching the derail.

As an inspection showed that the plant was in good condition, the evidence goes to show that the signalman was in the right, and that the trainmen were responsible for the accident. The derail could not have been open while the signals were at clear, and as the signalman had been notified that a C., M. & St. P. Ry. train had left the next station while the W. C. Ry. train was an extra of which he had not been notified, it was natural that he should have had the signals set for the C., M. & St. P. train, and consequently against the W. C. train. The speed was such that if the switch had not turned the engine off the track it would have run on the ties clear to the crossing.

The interlocking plant was installed in 1896, the material being supplied by the Union Switch & Signal Co., of Swissvale, Pa., and the erection being done by the Chicago, Milwaukee & St. Paul Ry., under the supervision of Mr. W. H. Elliott, Signal Engineer of the road. It is a 20-lever machine, with no spare spaces, there being 11 levers for 15 signals, and 9 levers for 12 switches and locks and 2 signals. The plant is operated by towermen supplied by the Wisconsin Central Ry., while the maintenance of the plant is in charge of the C., M. & St. P. Ry.

THE CLASSIFICATION OF LAKES ACCORDING TO TEMPERATURE.

A paper with the above title, by Mr. Geo. C. Whipple, Director of the Mt. Prospect Laboratory of the water-works of Brooklyn, N. Y., appeared in "The American Naturalist" for January, 1898, and has been reprinted for private circulation. The paper is a suggestive one, and it is to be hoped that it will prompt a number of people to add to the rather limited series of observations now available on the temperatures of lakes at different depths. The importance of the subject lies largely in the fact that the vertical circulation of water in lakes, ponds and reservoirs, used for public water supplies often has a direct relation to the quality of such supplies. This is due to the fact that under certain conditions of depth and temperature the water overturns, perhaps bringing stagnant water to the surface that is of objectionable quality, or which contains organic matter affording large quantities of food for organisms whose life processes impart offensive tastes and odors to the water.

Mr. Whipple divides lakes into three types, polar, temperate and tropical, and then subdivides each of these types into three orders. The nine classes are described by him as follows:

> In lakes of the polar type the surface temperature is never above that of maximum density; in lakes of the tropical type it is never below that point; in lakes of the temperate type it is sometimes below and sometimes above it. This division into types corresponds somewhat closely with geographical location.
>
> The three orders of lakes may be defined as follows: Lakes of the first order have bottom temperatures, which are practically constant at or very near the point of maximum density; lakes of the second order have bottom temperatures which undergo annual fluctuations, but which are never very far from the point of maximum density; lakes of the third order have bottom temperatures which are seldom very far from the surface temperatures. The division into orders corresponds in a general way to the characters of lakes; i. e., size, contour, depth, surrounding topograhpy, etc.

Diagrams are presented to illustrate this classification, and also to show the relative amounts of circulation in the several classes. Most of the lakes of the United States belong to the temperate type. In the first and second orders of this type two circulation periods, spring and fall, are possible, but in the first they generally fail to occur, and in the second always take place. In the third order there is circulation at all seasons, except when the water surface is frozen. Regarding a specific classification by lakes, Mr. Whipple says:

> In view of the comparatively few series of observations of the temperature of our lakes, the writer refrains from making any classification of the lakes of the United States, but the results thus far obtained seem to indicate that the first order will include only those lakes more than about 200 ft. in depth, such, for instance, as the Great Lakes, Lake Champlain, etc.; the second order will include those whose depth is less than about 200 ft., but greater than about 30 ft.; and the third order will include those whose depth is less than 25 ft. These boundaries are only approximate, and it should be remembered that depth is not the only factor which influences the bottom temperature.

A HIGHWAY BRIDGE WITH CONCRETE AND BRICK FLOOR.

By L. B. Merriam, C. E.

A modern highway bridge has lately been erected over the Kishwaukee River, in De Kalb Township, De Kalb County, Illinois. The point of interest in this structure is the unusually heavy dead load which is caused by the use of concrete and brick for driveway floor and concrete sidewalks. This bridge is at the city limits of De Kalb City, at the point where Main St., which is its principal business street, crosses the Kiskwaukee River and becomes a country highway. Just outside of the city the grounds of the Northern Illinois State Normal School begin. The township voted to improve the highway from the city limits west about one-half mile, under the Hard Roads Act. The engineer found that a bridge 65 ft. long from center to center of pins and having an 18 ft. roadway, was in existence. This bridge was founded on steel cylinders, with the cylinders set behind the stone abutments which had previously carried a shorter wooden bridge, and left only a 55-ft. clear waterway. Above this bridge, distant about 500 ft., is the bridge of the C. & N. W. Ry. Co., with a waterway of 80 ft. At each end of the railroad bridge there is an earth embankment, which is at least 15 ft. above the highest floods, which effectually confines the water to this opening. During the spring of 1897 several floods occurred, none of which reached the high-water mark of maximum floods. An actual observation of these floods showed a loss of head of almost one foot in forcing the water through this 55-ft. opening, and over the highway about 800 ft. west of the bridge. From the comparative volumes and the required velocity it was figured that not less than 14 ins. of head would be required to force this water through the 55-ft. opening at full flood, and this in a river which has a normal fall of only about two feet to the mile in this vicinity.

It was decided to put in a new bridge having a clear span of 80 ft., with new stone abutments. The roadway decided upon was to be 24 ft. wide in the clear, with an 8-ft. sidewalk on each side, outside of the trusses. As Main St. was paved with brick to the bridge and the new roadway to the west was to have a 30-ft. brick pavement, it was decided to pave the roadway of the bridge with brick, and to make the sidewalks on the bridge of concrete to correspond with those leading to it in the city. When this was determined upon, the next consideration was the construction of the sub-floor, and with this class of surface any form of timber sub-floor would be absurd. The first form which suggested itself was, of course, standard buckle-plate construction. An estimate on this form of floor was made as follows:

52,000 lbs. buckle plates at 3 cts.	$1,560.00
19 cu. yds. Rosendale cement concrete for roadway, at $3.50	66.50
26 cu. yds. Portland cement concrete for sidewalks, at $5	130.00
Total	$1,756.50

This was so high that the form of concrete subfloor finally adopted was estimated, as follows:

105 cu. yds. Portland concrete, including centers, at $6	$630.00
1,140 lbs. rods and nuts, at 3 cts.	34.20
Total	$664.20
Making a saving of	$1,092.30

However, this saving in cost was accomplished at the expense of increasing the dead load about one-third; or, in other words, 25% of the final dead load was caused by the increased average thickness of concrete. The total weight of steel in the finished bridge from the inspectors' reports was 85,000 lbs. Of this 40% was required to support the dead load; 25% of 40%, or 10% of this at 3c., cost only $255, leaving a net saving of $837. I need not add that the increase of dead load is certainly a benefit, when added, as in this case, without any increase of cost. The numerous tests of this and similar forms of construction, which have appeared in Engineering News from time to time during the last three years, have assured the author that this form of construction is safe, and in this case, at least, it has proved to be economical.

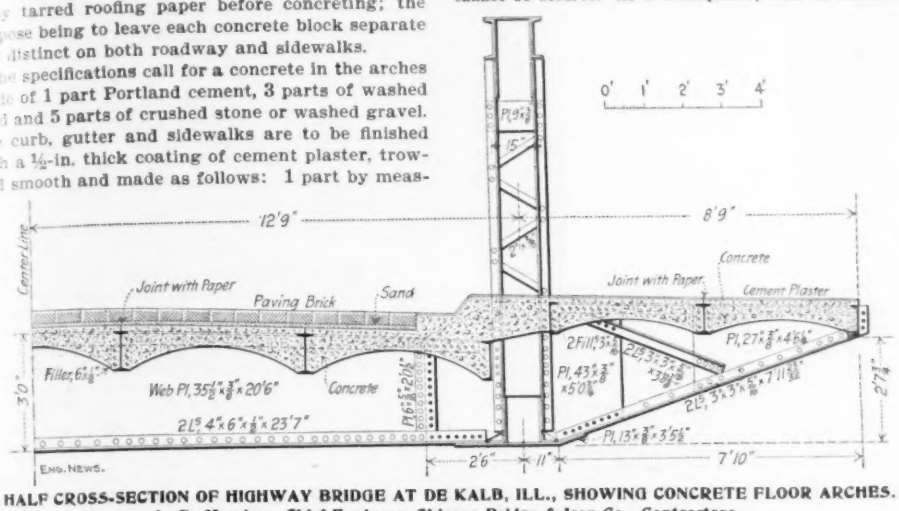
The Chicago Bridge & Iron Co., of Chicago, were the contractors for the entire structure, and the author was the engineer; metal and shop inspection were performed by the R. W. Hunt Bureau of Inspection. General plans and specifications were made as here indicated, and Cooper's 1896 Specifications for Steel Highway Bridges, was the basis of the steel work. Owing to the fire at the bridge works of the Chicago Bridge & Iron Co., the completion of the steel work was delayed to such an extent that it was not deemed good policy to place the concrete work this winter, therefore a temporary flooring of plank was laid over a portion of the roadway, and the construction of the final floor postponed until spring.

From the drawings forwarded with this communication, the bridge may be described as a riveted steel structure, 83 ft. long between centers of supports, 24 ft. clear width between trusses, and having two 8 ft. sidewalks outside of the trusses. Each truss was divided into five panels of 16 ft. 7¼ ins. each, with inclined end posts, and a height of 10 ft. between centers of chords.

The floor is the feature of interest. As shown in the section, the plate girder floor beams with curved top chord were connected by I-beam stringers, in such a manner as to leave spans of 5 ft. and 4 ft. 6 ins. between them; and these I-beams were themselves tied together at intervals of about 5 ft. by ¾-in. steel rods. Between these stringers the concrete arches are to be built, with a rise in inches not less than the span in feet between the I-beams and a thickness of 6 ins. at the crown. On the center line of each floor beam and on each longitudinal a vertical joint will be left by inserting a strip of 3-ply tarred roofing paper before concreting; the purpose being to leave each concrete block separate and distinct on both roadway and sidewalks.

The specifications call for a concrete in the arches made of 1 part Portland cement, 3 parts of washed sand and 5 parts of crushed stone or washed gravel. The curb, gutter and sidewalks are to be finished with a ½-in. thick coating of cement plaster, troweled smooth and made as follows: 1 part by measure of Portland cement and 1½ parts of washed torpedo sand or crushed granite. After the concrete floor has been laid at least 24 hours, 1½ ins. of clean, dry sand will be evenly spread upon the roadway, and on this will be set on edge a course of No. 1 standard, round-cornered paving brick, set with close joints and with the longest dimension at right angles to the axis of the bridge. After proper ramming the joints will be filled with hot paving pitch.

The method of building the concrete arches is, of course, not described; but centers of wood are apparently to be used in this work. It should be added that in figuring the weights of this floor the concrete was considered as weighing 125 lbs. per cu. ft., and the brick pavement and sand cushion were assumed to weigh 50 lbs. per sq. ft. of surface.



HALF CROSS-SECTION OF HIGHWAY BRIDGE AT DE KALB, ILL., SHOWING CONCRETE FLOOR ARCHES.
L. B. Merriam, Chief Engineer, Chicago Bridge & Iron Co., Contractors.

USE OF THE SMALL SIZES OF ANTHRACITE COAL FOR STEAM MAKING.

At the meeting of the Anthracite Coal Operators' Association, held in New York city, October last, a report was presented by a committee appointed at the April meeting to appeal to the transportation companies for a central stocking ground for the small sizes of anthracite coal, with which to meet the competition of bituminous coal. The committee formulated a series of questions which were sent to parties interested in the mining and marketing of anthracite, and it has prepared a digest of the replies which has been printed for consideration by the members of the Association.

From the report, which is printed in the "Association Letter," the monthly pamphlet published by the Secretary, Mr. Henry S. Fleming, No. 26 Cortlandt St., New York city, we have abstracted a number of the questions and answers, which may be of interest to those who are concerned in the increasing tendency in the Eastern states to substitute bituminous for anthracite coal. If anything can be done by the coal operators to cheapen the cost of small sizes of anthracite to the steam-user, or otherwise to induce him to use anthracite instead of bituminous coal, a public benefit will be done, by diminishing the smoke which is now becoming a nuisance in Eastern cities as it has always been in the West. The questions and answers quoted below include only those we deem of interest to coal users, those relating more particularly to the sizing of coal at the mines and the methods of the transportation and mining companies being omitted.

Have consumers been able to depend upon a regular supply of anthracite fine coal when the mines were working on short time?

In the large majority of cases consumers of anthracite small sizes can place no dependence on receiving a steady supply of these sizes. Those who have contracts with the transporting companies are often compelled to take larger sizes, chestnut, or broken, which are furnished at the contract price, because it is not possible to deliver a sufficient quantity of the small sizes. Consumers who buy according to their needs, and who may have been using a coal of excellent quality, have been compelled to fill their requirements with inferior grades, and frequently even these cannot be secured. As a consequence, with an abundance of bituminous coal at all times on the market, and at as low a price as anthracite, experiences of this kind naturally drive the consumer to soft coal, or, when in cities where smoke is prohibited, to a mixture of soft coal and small anthracite. Such a step once taken, it needs an extraordinary inducement to re-establish anthracite, and this will be even more difficult to accomplish when, as undoubtedly will be, a furnace is devised to burn bituminous coal without producing excessive smoke.

Must a supply of fuel come to them regularly, or can they carry enough stock at their works to last any length of time?

The majority of consumers, whether in cities or elsewhere, are unable, and probably unwilling, to carry any large stocks of fuel. An exceptionally small number have facilities for maintaining a supply sufficient for a month or six weeks, but many more do not carry above a week's stock, and still others, in some of the large cities, depend upon deliveries from day to day. It is essential, therefore, that all sizes of coal used for steam purposes should be delivered at regular intervals and without interruption.

Is it not necessary to have a stock of these smaller sizes on hand at some general stocking point on each road, sufficient to guarantee any industry a full supply of fuel at any time and throughout the whole year?

If manufactureres are induced to use these small sizes of anthracite, it is absolutely necessary to insure a regular supply, and there does not appear to be any practicable way of doing this other than to have some large stocking grounds on the line of the various railroads where any surplus may be stored until such time as it is needed to fill the demand. If regular stocking grounds were provided and properly equipped with labor-saving machinery, the cost of unloading, storing, and reloading would be reduced to such a small figure that every inclination would be toward storing any excess of these coals rather than taking the chance of breaking the market price, and further, of running short at a future time.

Has the size of the pea increased to such an extent that it has taken the place of chestnut?

It is difficult to say whether or not the size of pea coal has been increased so that it has taken the place of chestnut. Probably at some few breakers the screens are large enough to allow small chestnut to go into the pea, but the standard mesh is adhered to fairly well. Without regard, particularly, to size, it is undoubtedly true that pea coal has to a considerable extent taken the place of chestnut for domestic use. This is more a matter of a general change in the consuming market than of sizing, since those who have tried pea coal for domestic purposes have found that it serves as well as chestnut or larger sizes, and costs, retail, nearly two dollars per ton less.

Is pea used at any time for boiler fuel at the mines, and buckwheat and smaller sizes wasted because there is no market for pea? If so, to what extent?

Pea coal is rarely used as fuel at the collieries, and when this happens, it is generally because some unusual pumping or other work is being carried on, and more steam is needed than can be obtained from the small sizes generally used for this purpose.

Few of the collieries use buckwheat as fuel owing to there being no market for it.

At the great majority of mines, rice and the smaller sizes are used for steam making, and any excess above that required for this purpose is marketed.

What amount of pea and buckwheat is put on the dirt-bank for lack of market?

In practically no cases are pea and buckwheat thrown on the dirt-bank for lack of a market. They are often stocked when the market is overloaded, but are always taken up and shipped when the demand improves. Dirt-banks from old collieries contain these sizes, but in 1867 pea coal became a marketable product, and in 1876 buckwheat was separated, and since that time there has been a steady decrease in the amount of coal thrown away.

How much more rice and smaller sizes could be made at the breaker than are now made, if a market could be obtained for them?

In the absence of any actual trial, no reliable figures can be given to show how much more rice and smaller sizes could be made at the breakers if a market was obtained. It is variously estimated that from none to 30% more could be produced.

Can the fine sizes, buckwheat and under, displace bituminous coal in the Eastern market?

The steam sizes, buckwheat and smaller, can displace bituminous coal in the Eastern market, provided, that there is a certainty of regular delivery; and a price named which, for the unit of work done by them, is on a par with the cost of soft coal.

Manufacturers in the New England states and elsewhere prefer anthracite because of its freedom from smoke and dust, and the ease in handling. Even the very smallest sizes are acceptable, as where not burned alone, they are mixed with varying proportions of soft coal and produce an excellent fire, without smoke.

Are the small sizes below buckwheat valuable?

The small sizes of anthracite, below buckwheat, are valuable as fuel since they contain almost as much carbon as the larger sizes and have but little more ash and sulphur. It will be remembered that until 1863 even chestnut coal was thought too small to be a valuable fuel. In 1867 its use had largely increased and the next size smaller, pea coal, was separated and used to a very small extent. Then, in 1876, finding that both chestnut and pea had proved extremely satisfactory, the still smaller size of buckwheat was produced, and efforts were made, with moderately successful results, at using the material passing through the buckwheat screen, and to which the general name of "culm" was given. Since that time it has been found that, through improvements in grates and increased experience as to the best manner of burning, where there was greater regularity in the size of these smaller coals, more satisfactory results could be secured, and consequently there has been a further subdivision of "culm" into several intermediate sizes, all of which have been proved through actual and continued practice to be valuable fuels. With the best practice in furnaces and experienced firemen, it has been found possible to burn even the dust without admixture of other material, but where these matters have not received so much study and attention, a small admixture of bituminous coal has been used to bind together the extremely fine anthracite, and this mixture has made a fuel which is easily worked and produces a strong fire without smoke.

As has been shown by the gradual development in the use of these sizes, the value as a fuel is inherent, but to apply it requires proper appliances, experience and skill.

To what extent can the small sizes displace bituminous coal in the Eastern market?

It depends entirely upon the amount of such sizes produced, always provided that the price is as low and delivery as certain, as bituminous.

In the absence of any reliable figures showing the consumption of either the anthracite steam sizes or of bituminous coal in these markets, it is impossible to state even approximately what additional tonnage could be absorbed. Those who sell in these markets have estimated that, with proper inducements, it would be possible to dispose of from 1,000,000 to 5,000,000 tons per annum more than at present, and some places the possible expansion of the market at nearly double the last figure.

Is not the use of pea and buckwheat in the Eastern markets, as a fuel, at present prohibited on account of prices?

In the Eastern market the use of pea and buckwheat coal as a fuel is restricted on account of the higher price which is charged for it as compared with that for which soft coal is sold.

In the city of Fall River, 25 years ago, the mills largely used anthracite chestnut for steam purposes. Pea coal was introduced, and supplanted chestnut. Then buckwheat became the favorite because of the lower price, and took the place of pea coal. Now, however, low-priced bituminous coal, the delivery of which can always be depended upon, has practically taken the market.

What prices, delivered, would be necessary to displace bituminous coal in the East?

The price necessary to enable anthracite small sizes to displace bituminous coal in the Eastern market must of necessity vary with the price of soft coal at the various points in that market.

The following estimates of price have been named:

Minimum, f. o. b., New York,		
Buckwheat No. 1		$2.00
" " 2		1.75
" " 3		1.50
Buckwheat, $1.75 delivered west of Cape Cod.		
Rice, 1.40 " " "		
Pea coal delivered, $2.00	(At mines, $1.00)	
Buckwheat, " 1.00	(" " .50)	
Rice, " .50	(" " .25)	

Basing a price on good quality bituminous, delivered alongside at Boston, at $2.50 per ton, then buckwheat should be delivered for $2.15 to $2.25.

While it is, of course, desirable to have some fixed price for the anthracite small sizes, it is manifestly impossible to do so if successful competition against bituminous fuel is intended. It will be necessary that the price should not only vary with the latter, ton for ton, but that, where conditions demand it, these sizes of anthracite be sold at a price equivalent to bituminous per unit of work done, and this, as is well known, is somewhat lower in the average of these sizes of hard coal, than in the best soft coal, though fully equal to middle grades of the latter.

Have you any information as to what proportion of anthracite—fine sizes—can be used with favorable results in connection with bituminous coal?

It is stated that 25% anthracite small sizes and 75% soft coal gives good results, and half of each gives a strong fire, with little smoke. Six or seven parts of anthracite dust to one of bituminous slack or fine coal makes a smokeless fuel which burns well, and increasing the proportion of soft coal makes a quicker fire, but produces more smoke. On some railroads a mixture of one-quarter bituminous and three-quarters anthracite fine coal has given excellent results. At some oil refineries near New York, the waste from the stills is mixed with Buckwheat No. 3, or rice coal, giving a strong fire.

In the report of the "Anthracite Waste Commission" a number of references are given showing the results of trials of mixing anthracite and bituminous coal in various proportions. From them it would seem that less depends upon the proportion of each of the fuels than upon the proper mixing, the character of bituminous coal used, the form of grates employed, and the skill and experience of the fireman. It is safe to say that from 5% to 95% anthracite may be mixed with a fair grade of bituminous coal and give satisfactory results.

What is the relative value of fine sizes of anthracite and bituminous coal?

In actual practice it is stated that from 8 to 14% more of the anthracite small sizes are required than when using good quality bituminous coal. The Pennsylvania Railroad has found that its locomotives required 10 to 14% more anthracite than soft coal and on another railroad about 10% more was required.

Does not coal "banked" lose a certain proportion of carbon, and does it not disintegrate, in time, so as to lose all its valuable properties as a fuel?

It is a disputed question as to whether coal that has been "banked" for considerable period loses much or little of its heating power. It is stated that chemical analysis fails to show any material difference between such coal and that freshly mined.

Without any reliable data to depend upon, there is a general impression that coal which has been in the culm bank for a number of years is not so satisfactory for fuel as that freshly mined. That such changes must be exceedingly slow, however, is shown in coal which has come from culm banks which have been exposed to the elements for 40 years and which is a good, marketable fuel.

BOOK REVIEWS.

STATISTICAL ABSTRACT OF THE UNITED STATES. 1897.—Twentieth number. Prepared by the Bureau of Statistics, under the direction of the Secretary of the Treasury. Washington Government Printing Office. Cloth, 9 × 5¾ ins.; pp. 412.

This is an abstract of government statistics to and including the fiscal year 1897, relating to population, finance, commerce, agriculture and other leading products, mining, railways and telegraphs, immigration, education, public lands, pensions, postal service, prices, tonnage, etc. The comparative statistics are carried back in many cases 40 or 50 years, and the "Abstract" forms a compact and exceedingly valuable book of reference under the above given heads.

THE RAILWAYS OF INDIA FOR 1896-97.—Administration Report. By G. A. Anderson, Official Director of Railway Traffic and Statistics. Part II. Calcutta; Superintendent of Government Printing. Boards, 13 × 8½ ins.; pp. 167, and appendices pp. ccccxv.; with a large and excellent railway map of India corrected to Sept. 30, 1897.

This report enters into the details, for all the Indian lines, of stores on hand, capital accounts, statistics, revenue earnings and expenditures and school and fine funds. The voluminous appendices carry this information into minute detail. As all values are expressed in the fluctuating Indian currency, it is difficult to attempt any general summaries of financial results. The statement that the average sum received per passenger per mile was "2.08 pies," would be somewhat misleading to an American reader; and the conversion of these values into United States currency would be almost impossible for the reason noted. The railway map of India, accompanying this report, is the best and most complete that we have yet seen.

A SYSTEM OF EASY LETTERING.—By J. Howard Cromwell, Ph. B. Spon & Chamberlain, New York. Cloth; oblong; 8 × 5¾ ins.; pp. 26; 50 cts.

This system is based upon the division of the space to be lettered into squares, or into parallelograms, and the various types of letters here given conform strictly to these pencil lines and depend upon them for their proportions. This system does not admit of curved forms, other than can be made by chopping off the corners of letters on an angle of 45°. The system may be easy enough, but no one who has ever studied the art of lettering need be told that rigid adherence to arbitrary squares can only result in badly proportioned letters, unpleasant to the eye, and in many cases difficult to read.

THE BAROMETRICAL DETERMINATION OF HEIGHTS. A practical method of barometrical levelling and hypsometry for surveyors and mountain climbers. By F. G. B. Cordeiro, Surgeon U. S. Navy. Spon & Chamberlain, New York. Flexible morocco, 6¾ × 4¾ ins.; pp. 28. $1.00.

This work was entered for the Hodgkin Prize Competition, held under the auspices of the Smithsonian Institution, and received honorable mention. In it Dr. Cordeiro discusses the problem of barometrical hypsometry, before untouched since the Guyot treatment of 1851, and he has detected important errors in assumptions in the older formulas and proposes a new method which he claims is both rigidly accurate in theory, and will give reliable results in practice under all conditions. This method takes into account the varying weight of the air at intervals of ascent, the change due to variation of temperature and the relative humidity of the air. He therefore uses the mercurial barometer, thermometer and hydrometer. He gives tables of the variability of gravity at various points, of pressures at saturation for different temperatures of aqueous vapor, and of the elastic force of saturated aqueous vapor. In an appendix he discusses the efficient air-barometer, in which the tube is a spiral, with the bulb in the center.

L'ELECTRO-CHIMIE.—Production Electrolytique des Composes Chimiques. Par Ad. Minet, Ingenieur-Chimiste, Directeur du Journal "L'Electrochimie." Encyclopedie Scientifique des Aide-Memoire. Paris: Gauthier-Villars et fils. Paper; 7½ × 4⅝ ins.; pp. 167; illustrated.

This work treats of the decomposition of chemical compounds by means of an electrical current. The first part is devoted to the electrolysis of water, and the industrial production of hydrogen and to the electrolysis of acids and alkaline solutions. Included in this part is the electric decomposition of chloride of sodium and the production of bleaching, or disinfecting compounds, and of chlorate of potash, etc. The second part treats of the application of electrolysis to organic chemistry. Here we have discussed the rectification and aging of alcohol, the preparation of coloring matter, iodoform, bromoform and chloroform. Considerable space is also given to electric tanning and to the electrical purification of sugar. The work forms one of the scientific series issued under the direction of M. Leaute, Member of the Institute of France.

CIMENTS ET CHAUX HYDRAULIQUES.—By E. Candlot. Second and enlarged edition. Baudry et Cie, Paris, 1898. 8vo.; cloth; pp. 452; illustrated; 15 francs.

The first edition of Mr. Candlot's book, which appeared in 1892 or 1893, has everywhere been accepted as a standard work on the subject he deals with, and is perhaps more widely quoted than any other treatise. Mr. Candlot is a distinguished engineer and a manufacturer as well, and he has succeeded in making his book both eminently practical and scientifically accurate. It is peculiarly an engineer's book.

The second edition is considerably enlarged and revised, and yet contains nothing superfluous. As Mr. Candlot explains in his preface: "Without considering superannuated processes which have only a retrospective interest, without wishing to describe devices which are daily invented, and most of which are never even seriously tried, we have been contented to make known the processes of manufacture most commonly employed, and among recent makers, have chosen those which present original features and which appear destined to give practical results."

The theoretical questions involved in the set and hardening of cements are handled in a way which at once impresses the reader as correct and satisfying. The experiments described in the chapter on the effects of calcium chloride and calcium sulphate are fine examples of inductive method. Considered as a whole the book may fairly be rated among the best treatises which have appeared on the production of cement and the use of hydraulic mortars.

THE TORPEDO-BOATS "GWINN" AND "TALBOT," built by the Herreshoffs, had their official speed trial on March 3, and exceeded their contract speed. The "Gwinn" made an average of 20.9 knots, and the "Talbot" 21.1 knots; with average steam pressure of 208 and 194 lbs., respectively, and 430 and 422 revolutions per minute.

ANOTHER EAST RIVER BRIDGE, crossing Ward's Island to Long Island, at Hell Gate, is the subject of a bill introduced into Congress on March 3. By this bill the New York Connecting Railway Co. would be authorized to construct a bridge at this point with two or more railway tracks, to be operated by steam or electricity, and a passage for foot passengers. The bottom chord at the Hell Gate Channel must not be less than 140 ft. above mean high water, and not less than 80 ft. and 100 ft. respectively above Bronx Kill and Little Hell Gate channels. All plans must be approved by the Secretary of War, and the bridge would be open to the use of all railways conforming to reasonable regulations and paying proper tolls to the company owning the bridge.

QUADRUPLE EXPANSION MARINE ENGINES will be used on the lake steamer "William R. Linn," now being built by the Chicago Shipbuilding Co., for C. W. Elphicke & Co., of Chicago. The steamer will be 420 ft. long over all, 400 ft. long on the water line, 48 ft. beam on the water line, and 28 ft. deep, with a loaded draft of 18 ft. and a displacement (loaded) of 9,000 tons. The screw will be driven by a quadruple engine of 2,500 HP., having cylinders 21, 29, 42 and 64 ins. diameter and 42 ins. stroke. Steam will be supplied by two Scotch boilers, 12 ft. 6 ins. long and 14 ft. 8 ins. diameter, carrying a pressure of 200 lbs. per sq. in. Each boiler will have three furnaces. The ordinary speed will be about 12 miles per hour. The vessel will carry 6,500 tons of freight and will have accommodations for eight passengers. The owners inform us that the vessel will carry ore, grain and general freight, and will not run on a regular route, but whenever it will be most advantageous for the owners, being in fact a lake "tramp" steamer.

DAMS ACROSS THE NILE, at Assuan and Assiut, have been contracted for between the Egyptian government and Messrs. John Aird & Co., in connection with the extension of irrigation projects. The Assuan dam will be built of granite ashlar founded on the granite reef crossing the river. It will be 76 ft. high and about 6,000 ft. long, and the difference in water level above and below the dam will be 46 ft. The approximate storage capacity will be 1,065,000,000 cu. meters. Locks will be built for the passage of Nile steamers. The Assiut dam is intended to increase the distributing power of the canals in Middle Egypt and the Fayoum, and in design will be similar to the barrage above Cairo. The contract calls for completion of the whole scheme in five years, with annual payments of $800,000, and a concession lasting 30 years after the completion of the dams.

THE DYKING OF THE NIEMEN DELTA, emptying into the Gulf of Courland, near the boundary of Russia and Germany, has been completed. This delta is formed by the meeting of the rivers Russ and Gilge; the soil of the delta is continually watersoaked, and when ice blocks the rivers the high tides at times cover all the delta. This was the condition previous to 1892, when a project was adopted for building a new dyke, 18 miles long, almost parallel to the shores of the Gulf of Courland and uniting the old dykes of the rivers Russ and Gilge. This dyke has an average height of 6.6 ft., a width of 8.2 ft. at the top, and is made of sand and clay resting upon a substratum of sand relatively resisting. Where this dyke cuts the secondary arms of the two rivers nine locks are located, which were useful during construction and in afterwards controlling the flow in these branches. Six pumping stations, operated by electricity, are also erected for draining the land inside of the dykes. The territory thus dyked in has an area of about 44,500 acres. The total cost of the work was about $510,000; of which sum $380,000 was expended upon the dykes and $120,000 upon the drainage plant.

PNEUMATIC TUBES FOR MAILS are not approved of by Mr. Charles U. Gordon, Postmaster of Chicago, in his report to Mr. Gray, the Postmaster-General. He considers that the use of small tubes and small carriers will enable only a comparatively small amount of mail to be handled, and advocates the use of some electric or cable system with conduits large enough to take ordinary mail sacks, so that the mail assorted and packed at the post-office could be sent directly to the mail cars at the railway stations without having to be rehandled, as it would be if sent in packages through 6, 8 or 10-in. tubes. This would also enable through mail sacks to be sent direct from one railway station to another. Mr. Gordon has examined the pneumatic system in use at New York, Philadelphia and Boston, but reports that while they may be advantageous under the conditions obtaining in those cities, they would be of little value in Chicago.

AN INTERNATIONAL MOTOR-CARRIAGE EXPOSITION is being organized by the Automobile Club, of France, to be held in the Garden of the Tuileries, in Paris, between June 13 and July 3, 1898. The eight classes of exhibits invited are as follows: Automobile carriages of all kinds and motor-cycles; motors for motor-carriages; tires for motor-carriages; carriage bodies; detached parts for motor-carriages; materials of construction and special tools; appropriate dress and accessories for use with motor-carriages, and newspapers, books, photographs and drawings relating to this industry. Only such vehicles will be admitted as have previously made the trip from Paris to Versailles and return, under the control of a committee appointed by the Club. All communications concerning this Exposition should be addressed to the office of the Exposition, 4 Place de l'Opera, Paris. To receive admission, all applications must be made before May 10, 1898.

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